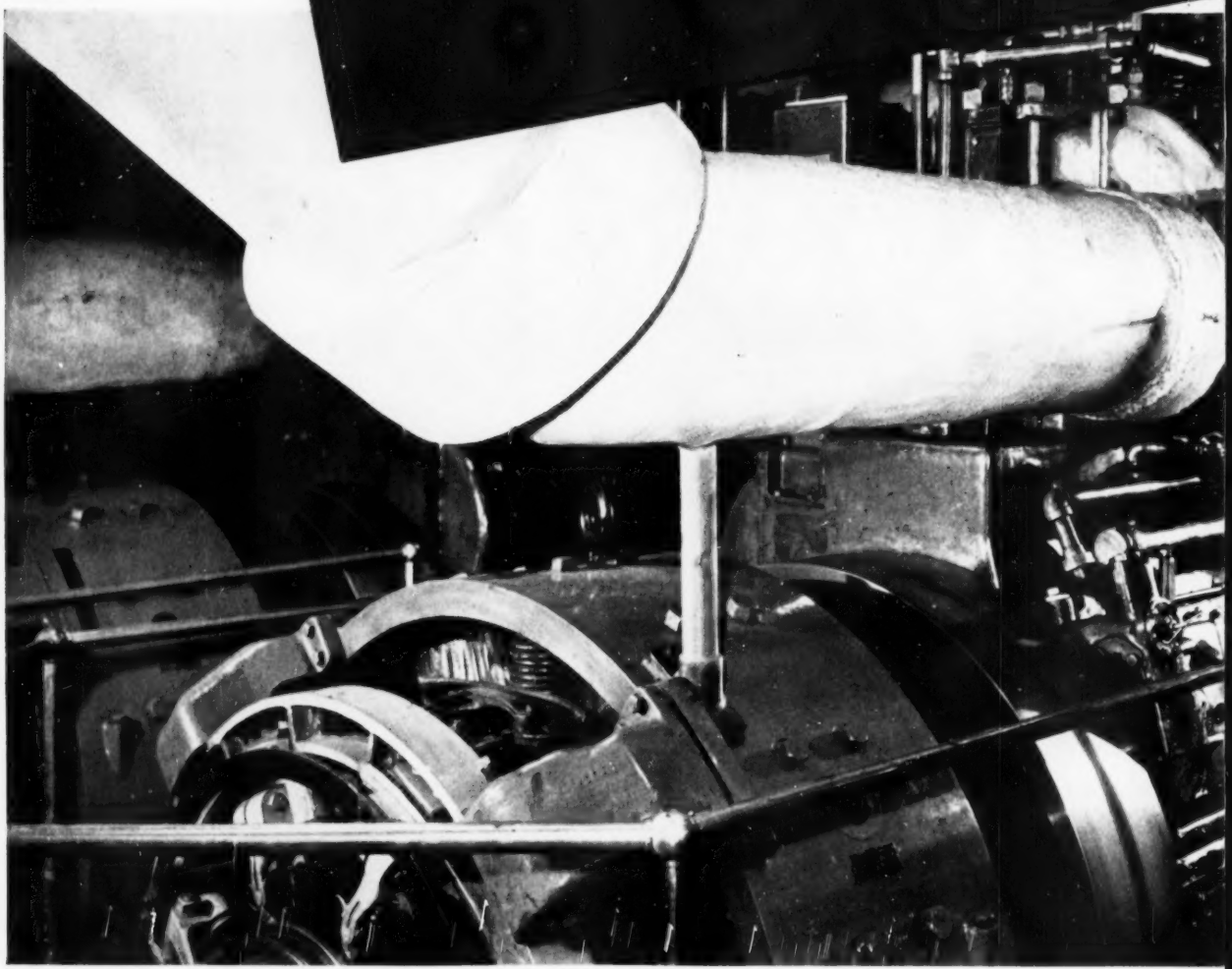
Diesel Power
& Diesel Transportation

Our 29th Year

JULY, 1951

Sing a song of savings

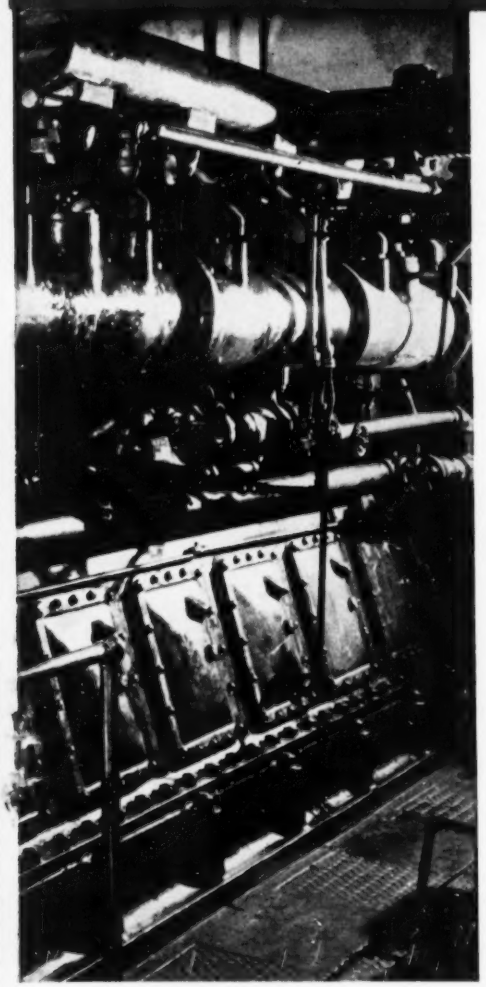


TEXACO

TEXACO

DIESEL POWER and DIESEL TRANSPORTATION for July, 1951, Vol. XXIX, No. 7. It is published monthly by Diesel Publications, Inc., Orange, Conn. Executive and Editorial offices at 192 Lexington Ave., New York 16, N. Y. Subscription rates: United States, $3.00 per year, single copies 35¢; Canada $4.00; Foreign $5.00 per year. Entered as second class matter April 29, 1949 at the Post Office, Orange, Connecticut, under Act of March 3, 1879.

Lubricate with TEXACO URSA OILS



Your engines – Diesel, gas or dual-fuel – will really hum when you lubricate with *Texaco Ursa Oils*. And *you'll* sing their praises when you see how these famous oils resist oxidation . . . assure clean engines, free rings, open ports and properly functioning valves . . . real harmony.

Texaco Ursa Oils thus assure better compression and combustion, smoother operation, minimum wear. Bearings and all moving parts last longer . . . maintenance costs and fuel consumption go down. Change your tune . . . switch to *Texaco Ursa Oils* for stepped-up efficiency and economy.

Texaco Diesel lubricating oils are available in every needed viscosity, and there is a complete line of them approved by leading engine builders. They are No. 1 in popularity from coast to coast! For example –

More stationary Diesel h.p. and more railroad Diesel locomotives in the U.S. are lubricated with Texaco than with any other brand.

Let a Texaco Lubrication Engineer direct you to greater savings throughout your plant. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

URSA OILS FOR ALL DIESEL, GAS AND DUAL-FUEL ENGINES

If you manufacture:

Combines
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You can get **PETTER**
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IMMEDIATELY
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350 Fifth Avenue
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Petter

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Please send me without obligation complete information and prices on the Petter Diesel.

Horsepower required_____

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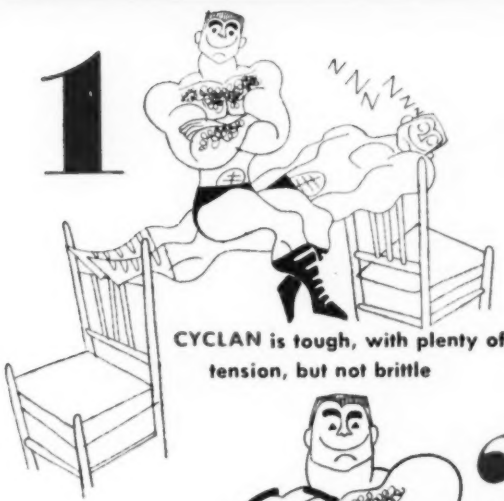
CYCLAN

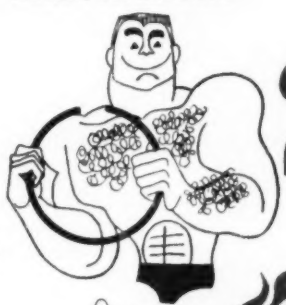
The new Piston Ring material for tough service in heavy duty Diesel and Gas Engines



1 **CYCLAN** is tough, with plenty of tension, but not brittle

4 **CYCLAN** withstands impact, hammering, flexing

CYCLAN has twice the breakage resistance of ordinary iron



2

5 **CYCLAN** withstands considerable distortion without losing shape

3 **CYCLAN** retains tension up to 700° F.

6 **CYCLAN** resists wear far better than standard ring iron

Available for rings up to 9" diameter.
Write for complete information

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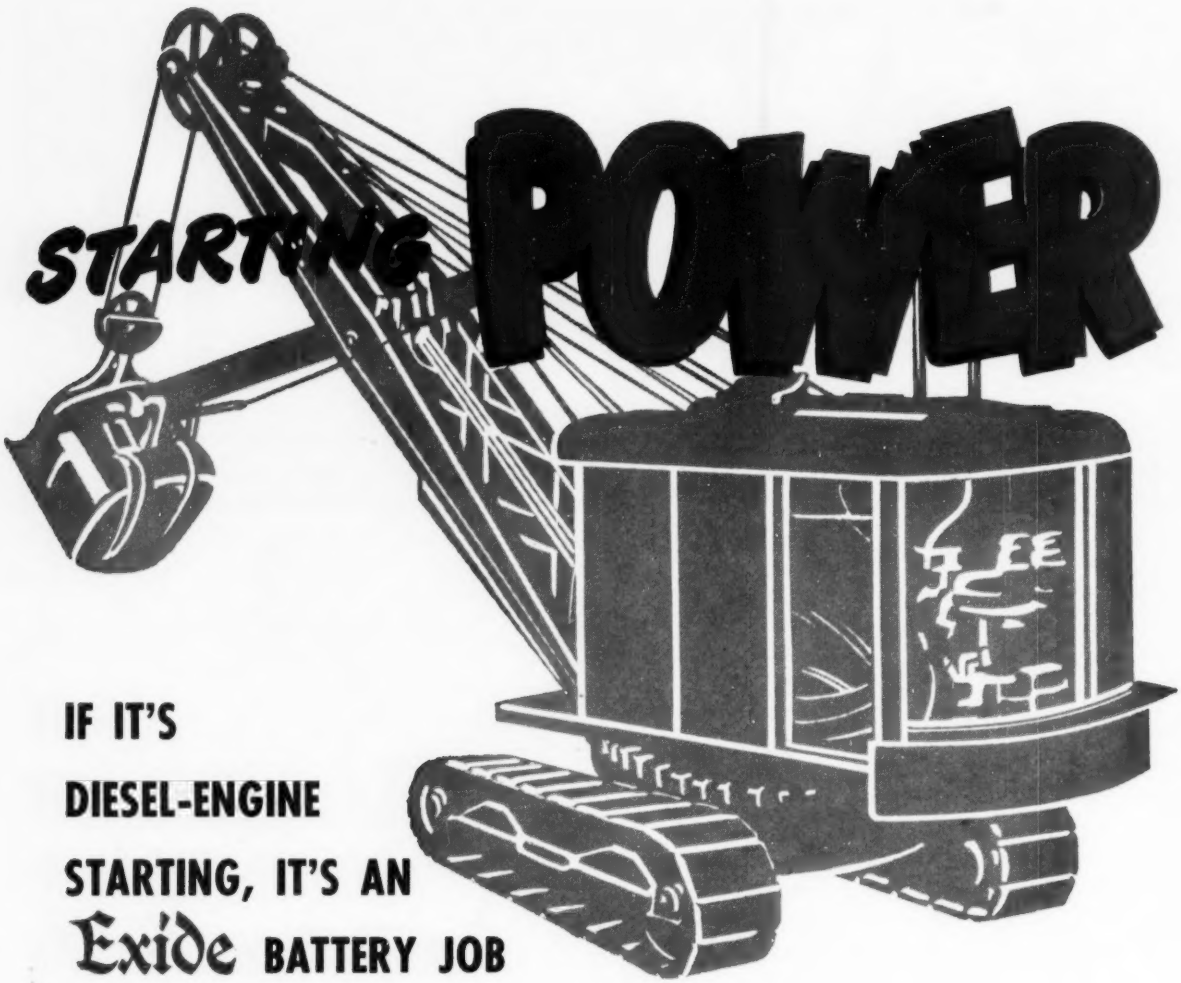

IF IT'S DIESEL-ENGINE STARTING, IT'S AN Exide BATTERY JOB

For dependable, all-weather, diesel starting, choose the battery that's designed specifically for the job—a powerful, long-lasting Exide. Back of it are years of ceaseless research-engineering and battery-building experience to give you assured starting, day after day, under the most severe operating conditions. With Exide batteries you get:

HIGH MAINTAINED VOLTAGE for a *quick breakaway* and *high cranking speeds.*

EXTRA LONG LIFE—low depreciation, less frequent replacements.

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RUGGED CONSTRUCTION for rough usage and hard service.

Use Exide diesel-starting batteries for all heavy-duty service . . . in buses, trucks, tractors, off-the-highway equipment, ships, aircraft, power plants, diesel-electric locomotives.

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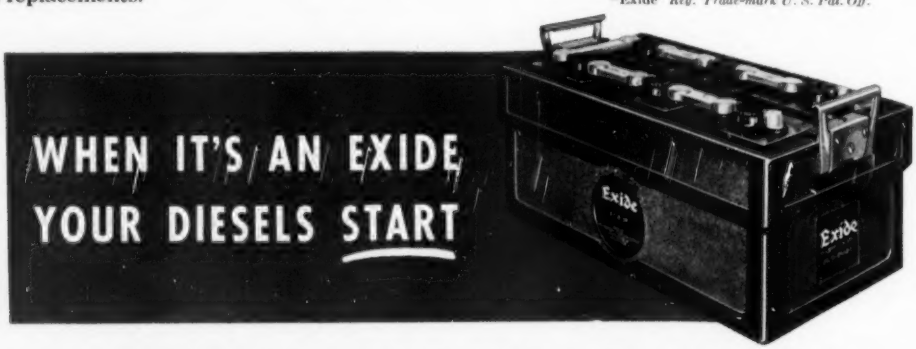

1888...DEPENDABLE BATTERIES FOR 63 YEARS...1951

10,500 FAIRBANKS-MORSE DUAL FUEL hp.

Three 3500 hp. Model 31's in new central station for Northeast Missouri Electric Power Cooperative.

DUAL-FUEL...

Teamed with Steam in new dual-power plant...

Here is an ideal combination of generating power—dual fuel engines, backing the big steam generating station being built for this group of six R.E.A. Cooperatives.

Why Dual Fuel? Dependability; fast, easy starting; lower operating costs. Although ideal for peak load and standby service, these engines seem destined for 24-hour duty in view of the current rate of increase in load in this rural area.

Why Fairbanks-Morse? Many types and sizes of proved dual fuel engines (including these 3500 hp. units) to meet a variety of load conditions; more than 50 years of experience in working with and solving the problems of publicly owned power groups.

For details on how this group's experience can help solve *your* power problems, write . . . Fairbanks, Morse & Co., Chicago 5, Illinois.

Facts About this Latest FAIRBANKS-MORSE DUAL FUEL Installation

Three 3500 hp. Fairbanks-Morse Model 31-AD-18 engines rated @ 350 hp/cylinder @ 277 r.p.m. . . . can be put on the line in less than a minute from a cold start . . . will operate at an estimated total fuel cost of under 4 mills/kw-h . . . can be switched instantly from oil to gas or from gas to oil . . . are complete with well-arranged automatic accessory equipment.

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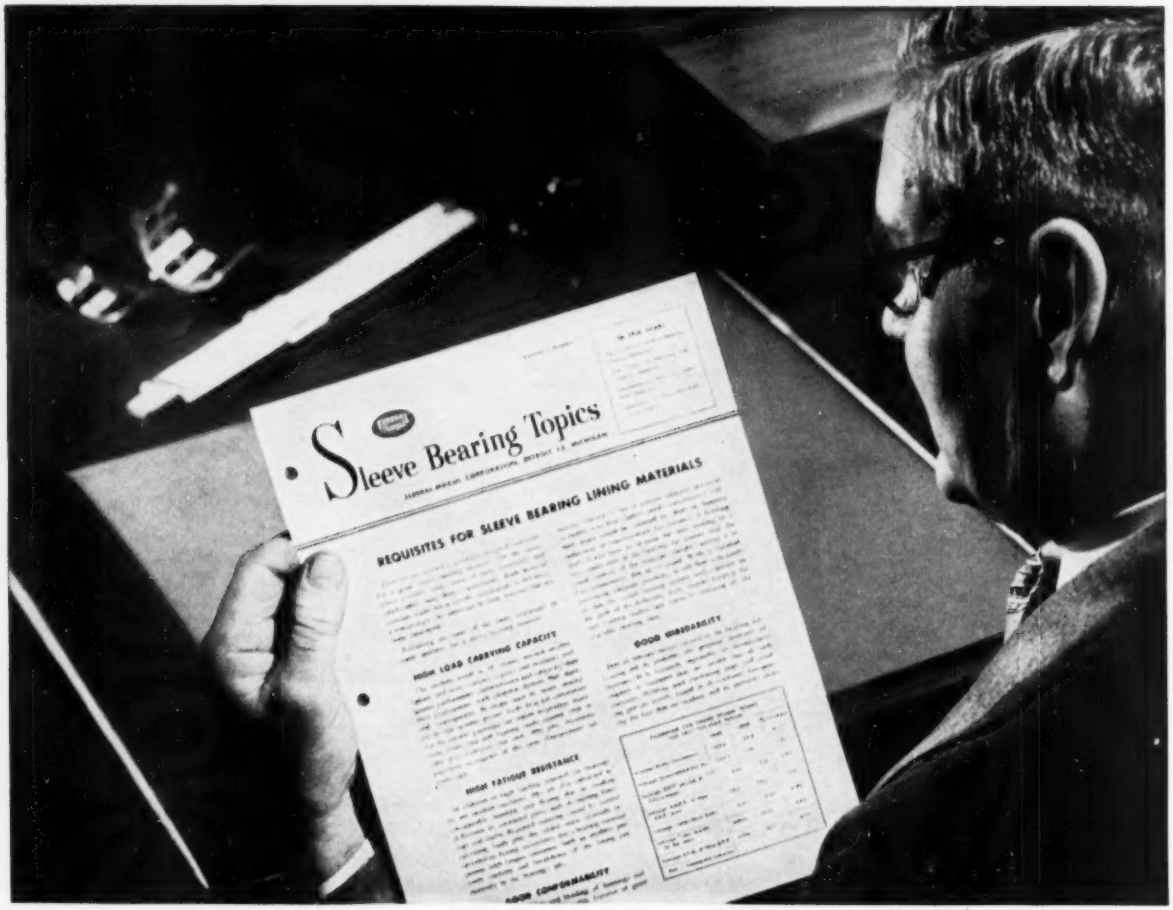
(DIESEL AND DUAL FUEL ENGINES • DIESEL LOCOMOTIVES • ELECTRICAL MACHINERY)
PUMPS • SCALES • RAIL CARS • MAGNETOS • FARM MACHINERY



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Here's a quick, convenient way for the designer, engineer and draftsman to keep up-to-date on developments in materials, design and applications of sleeve bearings, bushings and similar precision parts. The latest news on improved cast and sintered copper-leads . . . the new bi-metal rolled, split-type bearings . . . the re-design problems involved when shortages call for bearing lining changes . . .

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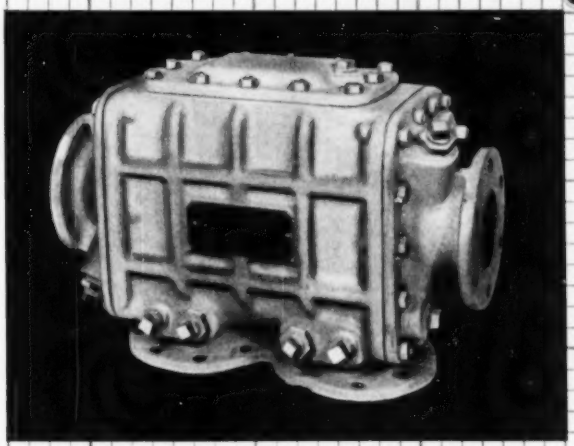
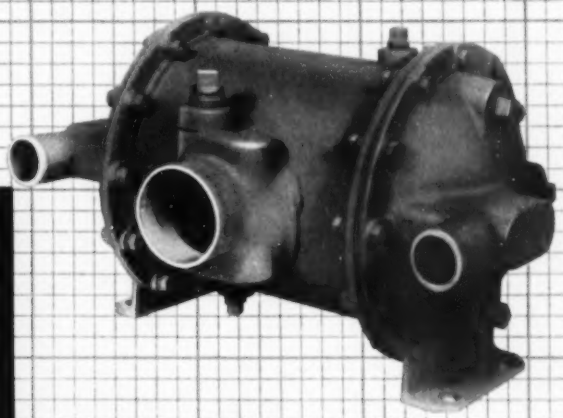
Since 1899

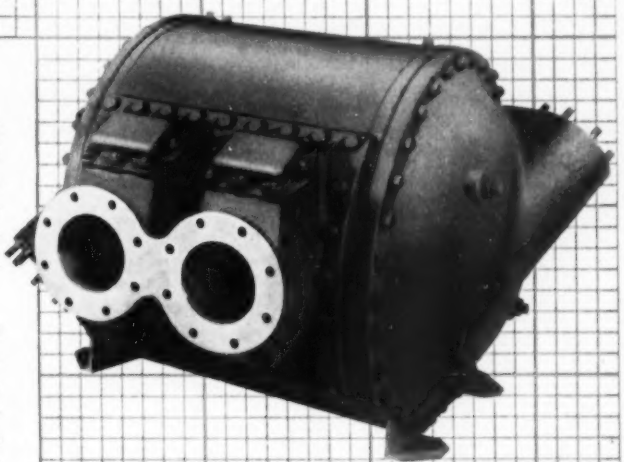
Our six plants produce sleeve bearings in all designs and sizes; cast bronze bushings; rolled split-type bushings; bi-metallic rolled bushings; washers; spacer tubes; precision bronze parts and bronze bars.





HARRISON
HEAT EXCHANGERS

outstanding performers



Developed by a design and engineering staff with wide experience in the field . . . built by one of the largest producers of heat-transfer equipment in the country . . . Harrison heat exchangers have long been first choice with leading manufacturers of Diesel equipment.

Manufacturers know that there is no compromise with quality at Harrison. Every Harrison installation is carefully engineered, thoroughly tested and skillfully produced. In addition, a capable field service organization helps our customers to get the most out of their installations.

Whatever your needs in heat exchangers, check first with Harrison. Our facilities are always available to our customers.

HARRISON RADIATOR DIVISION
GENERAL MOTORS CORPORATION
LOCKPORT, NEW YORK

HARRISON

YOU GET ALL 3—

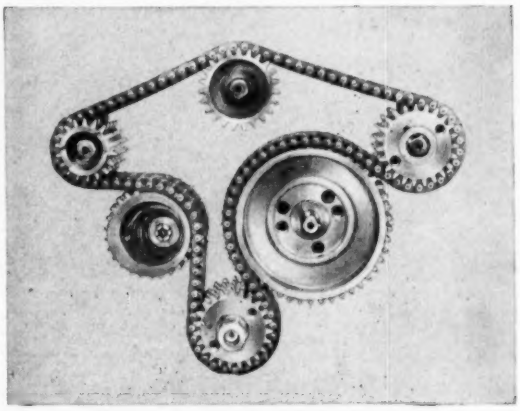
- AUTOMATIC JOINT SNUGNESS
- SMOOTHER OPERATION
- GREATER DESIGN FLEXIBILITY

...when you use LINK-BELT ...the world's finest timing chain from the world's largest chain plant

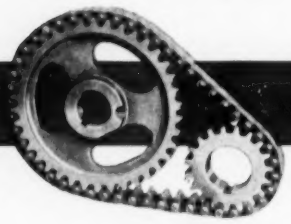
YES, you get superior performance . . . greater design flexibility when you work with Link-Belt Timing Chains and Sprockets. It's the highest load carrying chain on the market. Chains now being used by some leading car manufacturers measure only $1\frac{1}{16}$ inches in width. Narrower designs can mean a vital saving of space.

Equally important — the continuing research and unsurpassed facilities of the vast, new Link-Belt plant combine to make Link-Belt your best bet for a dependable chain source. Our engineers will supply a test drive to your specifications. There's no obligation, of course. Details are in engineering catalog No. 2065.

12.331



Link-Belt Duplex Timing Chain combines timing and accessory drive functions on this popular engine. Either face of the chain meshes with wheels.



ADVANCED JOINT AND LINK CONSTRUCTION

Removable case-hardened segmental liners or bushings extend across entire chain width —double bearing surface . . . halve bearing pressure on joint

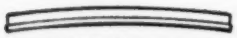
Broached holes in links form lock grip for bushings

Smooth, case-hardened pin, free to rotate between segmental bushings, presents every part of surface for wear

Bushing takes wear at joint—elongation of link hole or eye is negligible

AUTOMATIC JOINT SNUGNESS

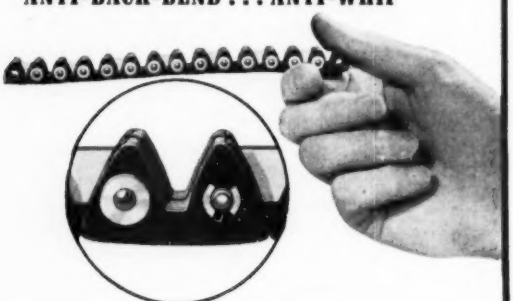
After initial assembly in chain, bushings are straight



Segmental bushings are made with slight bow

Bow in bushing acts to keep a snug joint, maintaining chain pitch

ANTI-BACK-BEND . . . ANTI-WHIP



Built-in check in joint limits bushing rotation, checks back-bend and whip

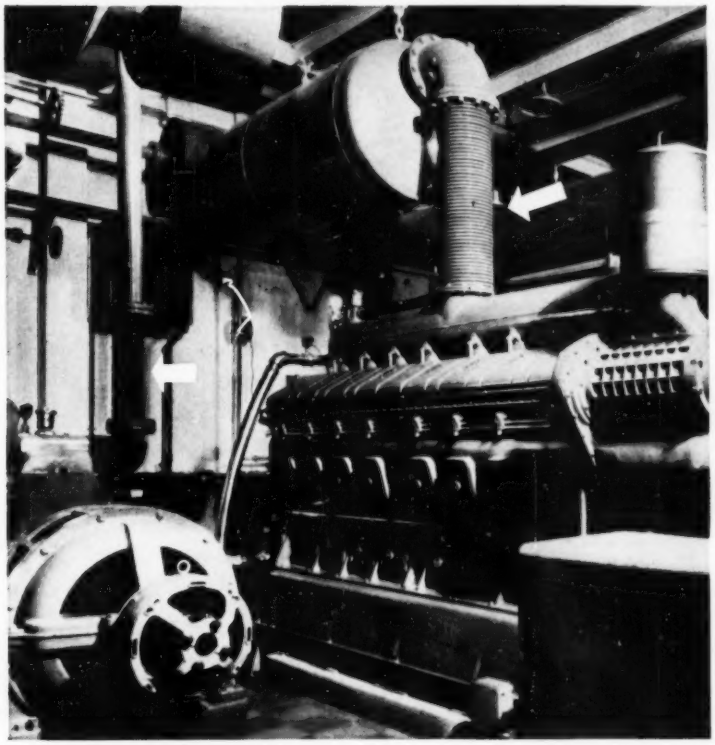
LINK-BELT

TIMING CHAINS AND SPROCKETS

LINK-BELT COMPANY: 220 South Belmont, Indianapolis 6, Ind
Offices in principal cities

Engineering logic says:

"Use American Flexible Exhaust Hose!"



Two factors *must* be considered in every diesel engine exhaust line: vibration, and the stresses created by wide temperature changes in the line. A third factor which *ought* to be considered: ease of installation and servicing.

American Flexible Steel Exhaust Hose—either corrugated or interlocked—solves all three problems. This sturdy, *flexible* steel hose absorbs, and thereby isolates, vibration. It likewise copes with thermal expansion stresses—prevents possibility of sheared bolts or cracked piping. And as for installation, there's no easier way to make an offset connection than with American Flexible Metal Exhaust Hose.

For full details on American Flexible Steel Exhaust and Air Intake Hose for diesel installations—marine and industrial, write for Bulletin EH-50. The American Brass Company, American Metal Hose Branch, Waterbury 20, Connecticut. In Canada: The Canadian Fairbanks-Morse Company, Ltd. 81263

OTHER PRODUCTS FOR DIESEL USE

Flexible tubing with wire braid cover for: starting air, circulating water, fuel oil, lubricating oil. Tubing available in bronze or carbon steel. Assemblies complete with fittings.

wherever connectors must move

ANACONDA
from mine to consumer

American **FLEXIBLE METAL HOSE AND TUBING**

MACK DIESEL TRUCKS

Get Things Done!

Extra effort — that's the order of the day as American industry swings into high gear to meet the growing demands of the nation's expanding defense program.

Nowhere is this more important than in vital truck transportation, the mobile production line that keeps raw materials flowing to plants and factories... speeds the products of America's farms and industries to consumers and the armed forces.

Here's work that's cut out for Mack diesel trucks... jobs where Mack diesels show at their best in rock-bottom operating economy... giving twofold advantages in more miles per gallon at less cost per gallon.

To their demonstrated economy Mack diesel-powered trucks add the further benefits of long-lasting Mack reliability and peak performance for the years to come. Your nearest Mack branch or distributor will show you how Mack diesels can *get things done* on your particular job... more dependably and at lower cost. You'll find it's a story well worth hearing.

Mack TRUCKS

... outlast them all

Mack Trucks, Empire State Bldg., New York 1, New York. Factories at Allentown, Pa.; Plainfield, N. J.; Long Island City, N. Y. Factory branches and distributors in all principal cities for service and parts. In Canada: Mack Trucks of Canada, Ltd.

Mack Model LJT, diesel-powered tractor serving Frozen Food Express of Dallas, Texas.

Clean Lube—Full Flow—with the TRULY POSITIVE Strainer

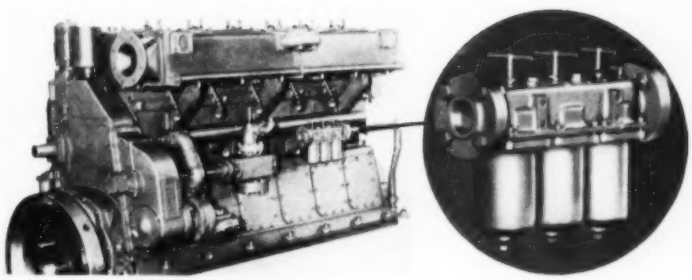
Sludge and other contaminants don't have a chance when the lube has to pass through a Cuno AUTO-KLEAN every time around.

The fixed-spaced metal discs in this modern strainer positively remove all solids larger than specified.* Cuno *guarantees* that.

The filter cartridge itself is cleaned positively and without stopping flow. Cleaner blades reach into the slots between discs to "comb out" all dirt, no matter how sticky or deeply embedded. This type of cleaning is much more thorough than mere surface-scraping . . . restoring full initial capacity—and there's no danger of the dirt being pushed through into the discharge flow.

Cuno AUTO-KLEAN discs are permanent, non-collapsible, unbreakable. No chance of an unsuspected gap or channel to occur, permitting passage of harmful solids. And—nothing to wear out and need replacing.

For permanent, positive Diesel protection, install compact Cuno AUTO-KLEAN. Send the coupon for free bulletin.



COMPACT, CONTINUOUSLY CLEANABLE Cuno AUTO-KLEAN Strainers are available for built-in or external installations, handling full flow in minimum space.

Continuously-cleanable feature permits single unit installations. Straight line connections for simplicity of installation on either fuel or lube. Can be cleaned periodically by hand or continuously by motor drive, without shutting down operation. Cleaning of the discs is accomplished—manually or by motor—while still operating.

**Models available for straining from .0035 to .062 in.*

SEND COUPON FOR INFORMATION ON CLEANING BOTH LUBE AND FUEL

CUNO

Complete Line Fluid Conditioning

Removes More Sizes of Solids from More Types of Fluids

MICRONIC (Micro-Klean) • DISC-TYPE (Auto-Klean)
WIRE-WOUND (Flo-Klean)

Cuno Engineering Corporation
2510 South Vine Street, Meriden, Conn.

Please send me free bulletin on Cuno AUTO-KLEAN Strainer for Diesel engine protection.

Name..... Title.....

Company.....

Address.....

City..... State.....

PLEASE ATTACH COUPON TO YOUR BUSINESS LETTERHEAD

SERVING THE DIESELS THAT SERVE AMERICA...

DELCO-REMY

Diesels are popular in the Gulf shrimp fleet . . . and Delco-Remy electrical equipment is popular on the Diesels.

Just another example of how Diesel manufacturers and Delco-Remy work together for better engineering, better equipment and better performance.

Delco-Remy heavy-duty generator and 30- 32-volt carbon pile regulator

DELCO-REMY—A UNITED MOTORS LINE
Service Parts and Delco Batteries Available Everywhere Through UNITED MOTORS DISTRIBUTORS

UNITED SERVICE MOTORS

Delco-Remy
DIVISION, GENERAL MOTORS CORPORATION
ANDERSON, INDIANA

DELCO-REMY • WHEREVER WHEELS TURN OR PROPELLERS SPIN

Mobilizing Diesels

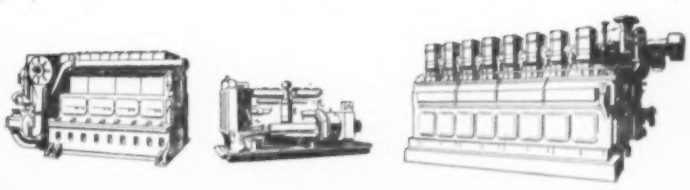
THE NATION wants peak production today. Much of the effort to achieve it must start at the source—with peak power output. So there's a big role to be played by Diesel engines. That points up an urgent duty of all those concerned with any Diesel operation: to re-examine not only their Diesel lubricants, but their entire Diesel lubrication practice!

Significant direct savings of oil can be made with the excellent lubricants Cities Service produces for all types of Diesels . . . for all operating conditions. But even more important is the power conserved . . . the saving of down-time—replacements—maintenance . . . and the improved production such savings permit.

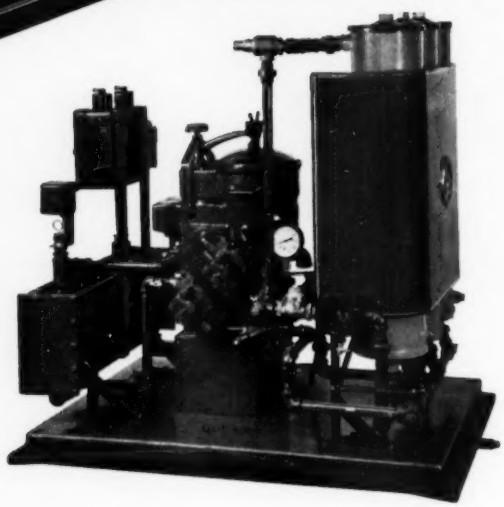
A well-established way to make sure of Diesel lubrication that effectively contributes to peak power output . . . helps maintain it even under adverse conditions . . . is to consult a Cities Service Diesel lubrication specialist. He's fully qualified by intensive training and by wide experience with all types of Diesels. And he's readily available on request. Address CITIES SERVICE OIL COMPANY, Room 12, Sixty Wall Tower, New York City 5. Write. Or phone your nearest Cities Service office.

CITIES SERVICE

Quality Petroleum Products



"PURI-FILTERED" OIL [illegible] CLEAN
YOU CAN READ [illegible] THROUGH IT!



Diesel lubricating oil that has been cleaned by a De Laval "Puri-Filter" is so clean that you can read a book through a test tube full. The oil is ***visibly*** clean — no dirt . . . no water . . . no colloidal carbon!

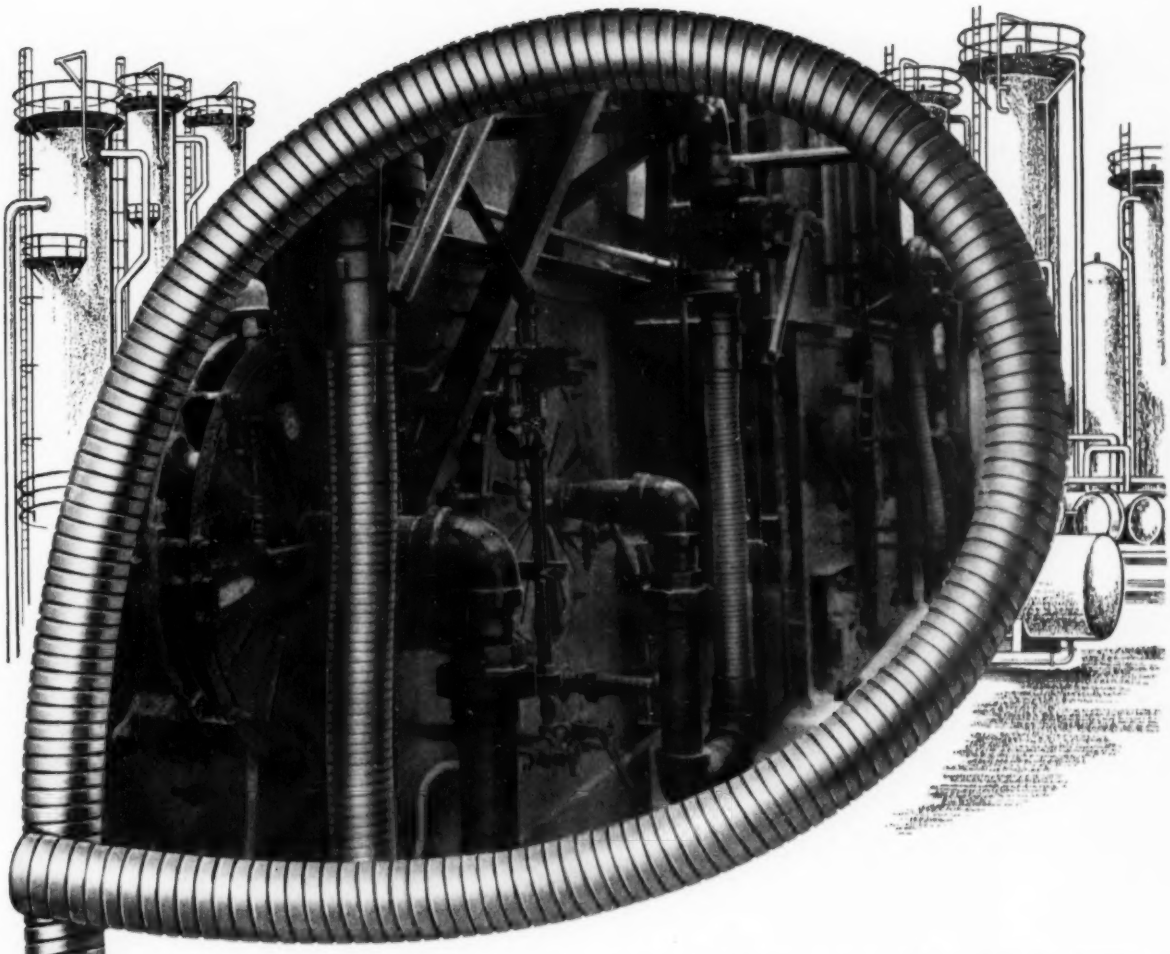
The "Puri-Filter" cleans oil two ways: (1) by centrifugal force, (2) by micronic filtration. First the De Laval centrifuge removes solid impurities and water, storing the dirt in the bowl of the machine and continuously discharging the water to waste. Then the lubricant is further purified by means of the filters which remove the specks of carbon that are lighter than the oil itself. You ***know*** that the oil going back to the crank case is clean.

De Laval "Puri-Filters" are complete, ready-to-run units. They are available in various capacities.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL *Oil Purifiers*

FOR DIESEL LUBRICATING OIL



CORRUGATED "MUSCLES" THAT LET PIPES MOVE

PENFLEX METAL HOSE ABSORBS THERMAL EXPANSION . . . PREVENTS JOINT LEAKS

Petroleum still burners like this one in Kermit, Texas, put heavy strains on piping. Thermal expansion, contraction and physical shock make safe sealing of burner pipe joint assemblies a vital requirement.

Penflex flexible metal hose with couplings is used on these burners to absorb any pipe movement due to extreme temperature and pressure changes. Lengths of 4" I.D. interlocking, four-wall galvanized steel hose are installed on each burner. Provides outstanding safety and high, uninterrupted flow of volatile fluids. Leakproof, tough and *flexible*.

Penflex engineers can help you solve flexible tubing application problems. Penflex manufactures a complete line of four-wall, interlocking and seamless welded corrugated tubing . . . from ⅛" I.D. and up . . . automatic barrel fillers, accessories and fittings. Write for illustrated folder, "Flexineering," containing valuable flexible tubing data for your product application.

Pennsylvania Flexible Metallic Tubing Company, Inc., 7236 Powers Lane, Phila. 42, Pa.

Branch Sales Offices: **Boston • New York • Chicago • Houston • Cleveland • Los Angeles**

Penflex

HEART OF INDUSTRY'S LIFE LINES

FOR DIESEL COOLING... **Here's Why**

"Buffalo" EVAPORATIVE COOLERS *do your job Better*

1. QUALITY IN ALL PARTS — Evaporative Coolers have Aerofin spiral fin coils, which are tops for long life and efficiency in liquid cooling. "Buffalo" aluminum wheel, hollow-shaft "mixed flow" fans, unexcelled for quiet delivery, supply the air for evaporation. Quality "Buffalo" pumps recirculate the spray water. In fact, quality construction through and through assures you a permanent unit that will save you many a "headache" later on.

2. SIMPLIFIED 3-SECTIONAL DESIGN means easy installation (sections pass through ordinary building openings) and simplified maintenance. Sections are in standardized units — blower head, coil and tank sections.

3. OTHER ADVANTAGES — include compact size, easy operation, water economy, indoor or outdoor installation.

WRITE FOR BULLETIN 3666. Look over the specifications, and you'll agree that these high-quality coolers pay for themselves in performance.

"Buffalo" FIRST FOR FANS

BUFFALO FORGE COMPANY

140 MORTIMER ST. BUFFALO, N. Y.

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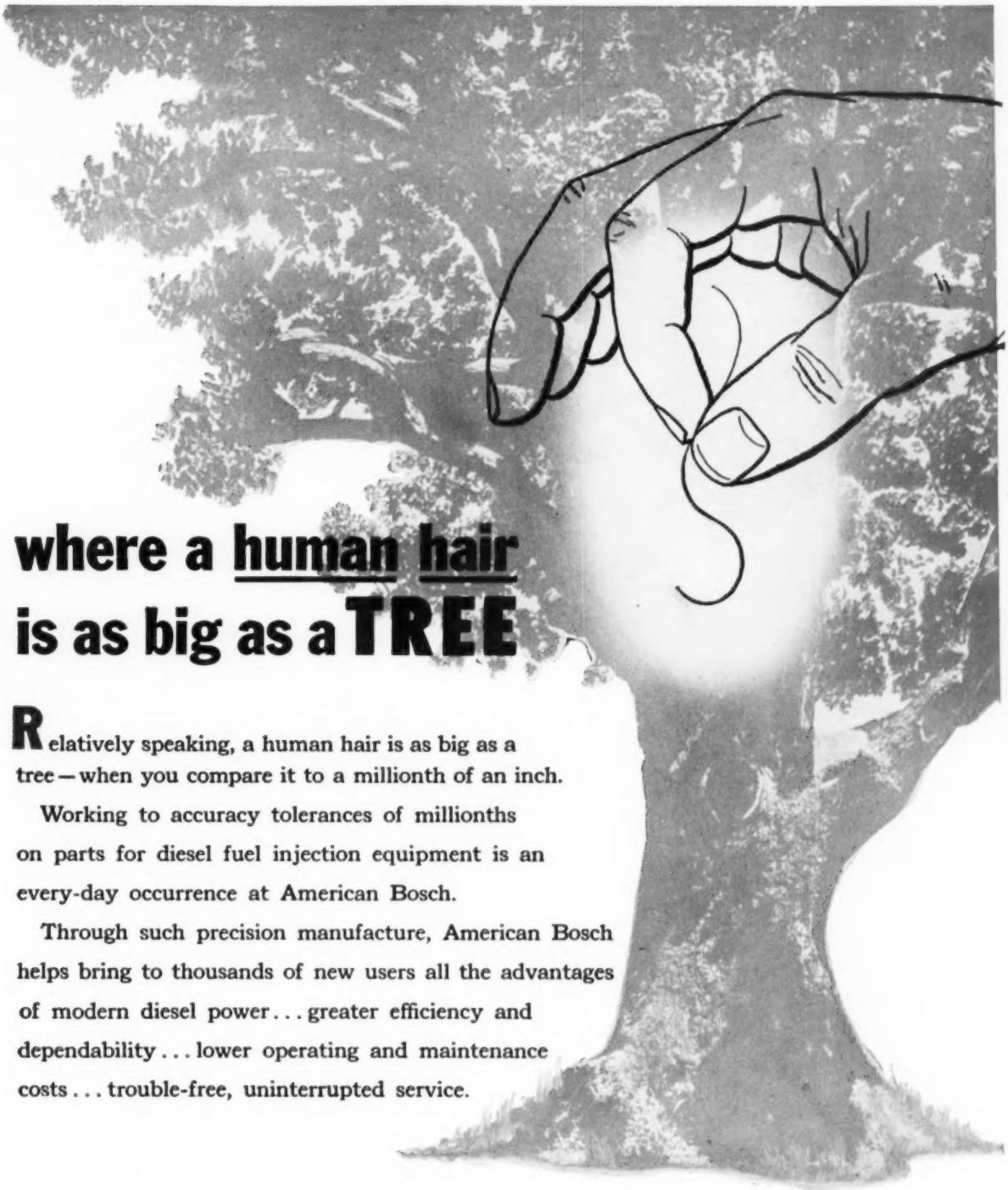

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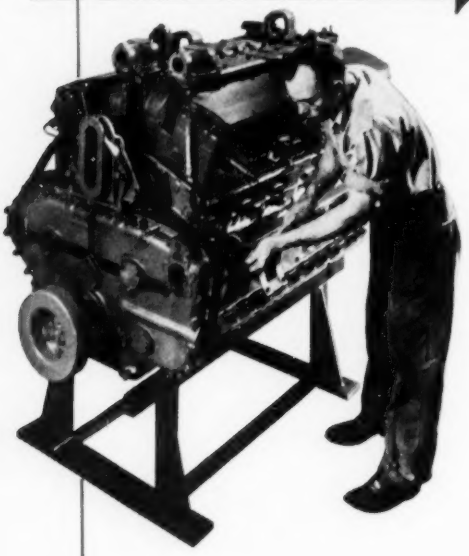

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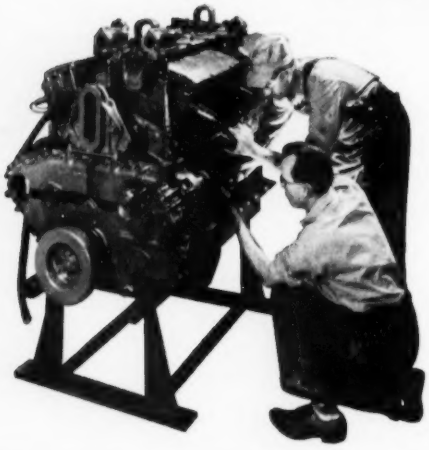

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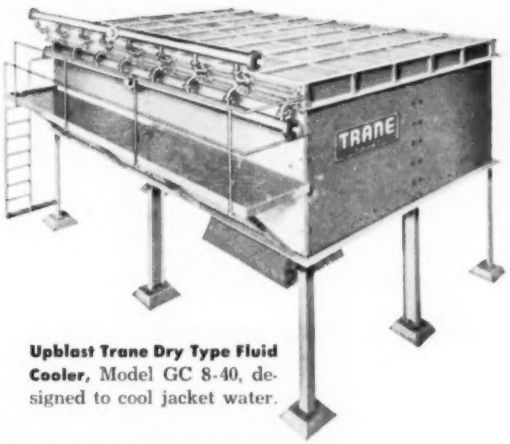
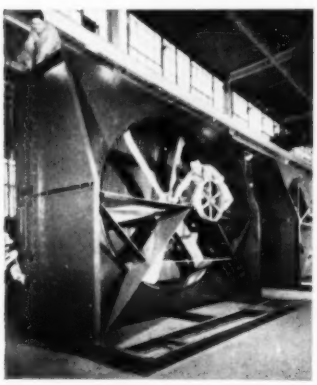
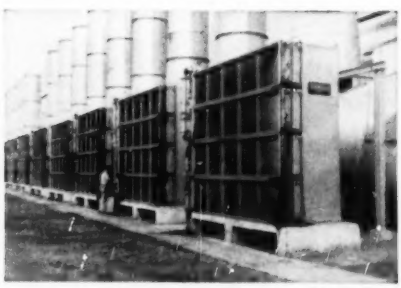


Upblast Trane Dry Type Fluid Cooler, Model GC 8-40, designed to cool jacket water.



Horizontal air stream model Trane Dry Type Fluid Cooler, Model EC 13-42, designed to cool water and oil.



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Diesel Power
and DIESEL TRANSPORTATION

Brian P. Emerson, Editor

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Scope of operation conducted by the Oliver Iron Mining Company in Minnisota practically dwarfs the many highly essential pieces of diesel equipment. Diesel locomotives, shovels, dump trucks, all contribute to economical and efficient operation.

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Editorial:

Locomotive Industry MUST Get Materials

NO matter what happens in Korea our rearmament program must not lag. Should a "cease fire" result, no basic issues will have been resolved. Any argument that the vast scope of our rearmament program was engendered solely by the military requirements of Korea is specious: This "police action" was a grim reminder that our military strength was dangerously low.

Now we are rebuilding so that we can meet any threat — and with good reason. Our military potential lies — not in manpower — but in our technological development and production. Efficient and adequate transportation is vital to production and for delivery of the goods produced.

In wartime, railroads bear the brunt of defense transportation. They carried 83 per cent of intercity freight during 1941 to 1944. Now, with the railroads depending on diesels, they have become one of our most important defense tools. That this is recognized is shown by the situation at American Locomotive. In the last war, locomotive production suffered because the government wanted their facilities for other heavy war materials. Alco again has a huge tank program, but this time things are different.

Locomotive and parts production is being maintained at normal, in fact, at peak level. Separate facilities as well as managerial and production personnel have been set up so that both essential programs can be carried out with no question of priority or interference.

The bugaboo of all defense production is materials. Conservation is the watchword and in this case simply emphasizes the fact that diesel locomotives should be built and built NOW.

The case for the diesel locomotive is most effectively presented in a booklet compiled by the Electro-Motive Division of General Motors entitled "America Needs More Diesel Lomotives Now." Some of the highlights will be quoted to emphasize our point.

In 1950 there were 18 per cent fewer locomotives than in 1940, and yet they did 30 per cent more work by using diesels. Diesels number less than 17 per cent of the total freight locomotives, yet they are doing 44 per cent of the work.

The diesel's greater hauling capacity means that more tons are handled by fewer trains. This reduces traffic density, speeds schedules and results in more work from every freight car, a critical item today.

This all adds up to direct saving in critical materials since fewer units need to be built for handling probable peak tonnages. This might be called direct savings to which can be added indirect, but none-the-less real conservation. To illstrate, dynamic braking alone saves many thousands of tons of iron in brake shoes each year. On one 4500-mile round trip of Santa Fe's *El Capitan*, over ¾ ton is saved—or more than 300 ton per year for just one 13-car *passenger* train.

High thermal efficiency is inherent in the diesel and the diesel will do as much work on one tank car of fuel oil as a steam locomotive will do on eight hopper cars of coal. Skipping over the fuel cost savings, think of the implications in the matter of fuel haulage where thousands of critically short cars are released for vital service as well as there being a reduction in congestion on the rails.

While on the subject of fuel, let's sketch the perennial idea that diesel locomotive fuel requirements are making serious inroads on the supply of petroleum products. Figures for 1949 show that the railroad diesel fuel consumption was less than 2 per cent of the total consumption of petroleum products. In 1950, on the basis of similar fuels the fuel oil used for heating alone was five times that used by the railways.

If the industry continues at its 1950 rate of production—3400 units per year—diesel locomotives in service in 1953 will use an estimated 214,000 bbl. of fuel per day. This is only 3 per cent of the petroleum industry's anticipated total production of 7 million bbl. per day.

As a final point on conservation, every ton of steel put into diesel locomotive building recovers at least 2½ tons of scrap in displaced steam locomotives—and, boy, do we need scrap.

Washington has shown alertness to the situation, as evidenced by their scheduled production and allocation of materials (*see Washington Slants*). It is incumbent on all concerned—and, actually, transportation affects us all—to see that the program is vigorously supported and pursued, so that all necessary materials are forthcoming.

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+ HIGHLIGHTS +

● New York State's highway tax on diesel fuel went up to six cents a gallon on July 1. The old rate was four cents a gallon.

● The Petroleum Administration for Defense has set a minimum goal of 43,400 oil and gas wells to be in operation at the end of the year.

● In the first five months of 1951, Class I railroads put 1048 diesel electric locomotives in service.

● Freight cars built in the U. S. during the month of May totaled 9774, just short of the 10,000 a month goal.

● The Alberta oil fields, which supply one-third of Canada's current petroleum requirements, have raised that country's annual crude oil production to nearly one-half of its needs.

● "Operation Greaseball", an all-weather test of lubricating oils and greases, has recently been completed by the Army. A new all-temperature grease was developed for use in a temperature range from minus 65 to plus 125° F.

● Defense Transportation Authority's suggested heavy truck program amounts to about a 30 percent cutback. Looks like they are underestimating their importance.

● Socony-Vacuum Oil Company reports that despite the impact of World War II the company is stronger than ever before in Western Europe. Refining capacity will average 90,000 bbl. per day, compared with 58,000 bbl. in the pre-war period. Product sales are expected to rise this year to 20 million bbl. compared with 8½ million in 1938.

● More than 13,000 types, sizes and kinds of carbon brushes are specified in the U. S. To correct this, NPA suggests that a standard list of 50 brushes be studied.

● The NPA campaign to collect 32 million tons of scrap steel this year is gaining momentum. Industrial leaders are surveying their plants for obsolete machinery, rails, pipe, etc., that can be disposed of as scrap.

● Westinghouse is reported designing a 15,000-kw., natural gas burning gas turbine, coupled to a hydrogen-cooled alternator. Maximum gas temperature is 1350° F. Unit is for the Public Service of Oklahoma, who previously ordered a 5000-kw. G-E gas turbine.

● Watch out! There are three new citizens of Texas — honorary to be sure. This honor was accorded by gubernatorial signature to the Chairman, Treasurer and Secretary (Ye Olde Editor) of the Oil and Gas Power Division, ASME, during the 23rd Annual Conference held in Dallas last month. A highly interesting and successful meeting, podner!

● During the month of May, General Motors Corp. produced 208,437 passenger cars and 58,619 trucks in its United States plants.

● NPA has compiled a list of 80 of the most frequently asked questions regarding CMP. Along with the answers, they are now available in booklet form. Bet they don't answer the question "Where is my Material?"

● The Northern Pacific Railway has petitioned the Public Service Commission of North Dakota for permission to operate trucks between Bismarck and Mandan, North Dakota.

● Junkers recently exhibited a free-piston diesel compressor at the Heavy Industries Fair, Hanover, Germany. Various types provide pressures from 42.7 to about 430 psi. and capacities from 495 to 70 cfm., free air.

● Director of Defense Mobilization C. E. Wilson announces strengthening of the Agencies to meet the expanding materials demands of defense production. Looks like materials will be even tighter.

● Sixteen nations participated in the recent International Internal Combusion Engine Congress held in Paris. Prof. P. H. Schweitzer, Penn. State College, delivered a paper entitled "Research in Exhaust Manifolds."

● The Reynolds Metals Co. has received an $85,000,000 loan to build a 150,000,000 pound a year aluminum reduction plant at Corpus Christi, Tex. and a 175,000-kw. gas diesel power plant, plus additions to the plants at Jones Mills, Ark. and Troutdale, Ore. This will increase the primary aluminum capacity of the company by 200,000,000 pounds a year.

Diesels in the Steel Industry

by George W. Grupp

IN some departments of the steel industry there is a definite trend toward diesel engines as prime movers. This is true of some mobile equipment, and especially of industrial locomotives and of locomotives used by the railroads owned by the steel industry.

Since about 40 per cent of the labor costs are for handling materials, from the extraction of raw materials to the shipping of finished products, every labor saving device and source of power which will reduce costs is employed by the steel industry—an industry with a capital investment of over $5,000,000,000 in property and facilities with an annual productive capacity in excess of 100,000,000 tons.

All of the principal steps of steel production are linked together with transportation from the mines to the finished products. And while it is true that 22 steel companies operate 263 steamships and only 17 motorships in the transporting of raw materials and finished products, yet in 1949-50 the 26 railroads owned by the steel industry operated 417 steam locomotives and 512 diesel electric lomotives. In their plants an increasing number of diesel industrial locomotives are used for intra-plant operation because of their performance efficiency and economy of operation.

During the past decade diesel electric locomotives have been replacing steam locomotives in the open cut iron mines of the Lake Superior area. In 1948 there were twenty eight 1000-hp. 125-ton diesel electrics in these mines. On grades ranging from 3 to 5 per cent these locomotives haul trains of eight 50- to 75-ton hopper bottom cars loaded with iron ore. On the same grades they haul trains of eight or more 30-cu. yd. side dump cars loaded with waste materials. During the past few years additional diesel electric locomotives have been placed in operation in these mines.

Out of 228 dump trucks of 9 to 30 tons capacity each used in 18 open cut mines, 225 of them are diesel powered. These trucks haul iron ore from the open pits to belt conveyors, to skips of vertical shafts, and to railroad cars. Diesel powered bulldozers, graders, and water sprinklers are used for the construction and maintenance of 25- to 70-ft. wide iron mine roads.

The first of the many diesel powered shovels now used in the Lake Superior open cut iron ore mines was placed in operation in 1920. Since then diesel shovels have increased in number because they are particularly advantageous in open cut iron ore mines with small daily tonnages as well as in larger mines where electric power is not available.

Most of the roller conveyor systems, rolls, cranes, ingot mold stripping machines, Hulett unloaders, and other material handling equipment used by the steel industry are operated by

Open cut iron mining, where diesels provide the power for a wide variety of operations.

Number of locomotives operated by steel industry owned railroads

(This does not include steel industry intraplant railroads)

Class I & II Common Carrier Railroad	*Total Trackage Miles*	*Number of Locomotives*	
		Steam	*Diesel*
Aliquippa & Southern Railroad Co.*	45.76	24	....
Bessemer & Lake Erie Railroad Co.	575.80	89	23
Birmingham Southern Railroad Co.*	62.76	....	17
Benwood & Wheeling Connecting Railway Co.*	6.20	....	3
Colorado & Wyoming Railway Co.*	115.23	17	3
Cuyahoga Valley Railway Co.*	15.19	13	....
Conemaugh & Black Lick Railroad Co.	44.13	12	25
Cornwall Railroad Co.	31.17	2	5
Carbon County Railway Co.*	18.08	....	2
Donora Southern Railroad Co.*	17.57	17	4
Duluth, Missabe & Iron Range Railway Co.*	1168.68	161	....
Elgin, Joliet & Eastern Railway Co.*	1084.68	....	148
Etna & Montrose Railroad Co.*	4.42	1	2
Fore River Railroad Co.	6.43	....	3
Hannibal Connecting Railroad Co.*	7.35	1	2
Johnstown & Stoney River Railroad Co.*	5.92	3	....
Lake Terminal Railroad Co.*	52.14	8	20
Monongahela Connecting Railroad Co.*	29.92	8	27
Monongahela Connecting Railroad Co.*	39.92	8	27
Newburgh & South Shore Railway Co.*	49.20	....	17
Northampton & Bath Railroad Co.*	13.65	....	3
Patapsco & Black River Railroad Co.	82.85	....	33
Philadelphia, Bethlehem & New England R.R. Co.	48.18	....	24
South Buffalo Railway Company	70.95	1	34
Steelton & Highspire Railroad Co.	33.88	....	12
Union Railroad Co.*	288.30	60	108

SOURCE: Interstate Commerce Commission. All figures are for 1950 except those marked*.

Number and Capacity of power shovels used in 25 open cut Lake Superior iron ore mines

Type of Shovel Power	Kind of Haulage	1-1¾	2-2¾	3-3½	4-4¾	5	6-6½	Total
		Capacity in cubic yards						
Diesel	Trucks	1	10	1	1	....	....	13
Diesel	Railroad cars	2	7	....	....	....	....	9
Electric	Trucks	1	9	6	20	6	1	43
Electric	Railroad cars	....	3	2	12	2	12	31
Steam	Trucks	....	....	....	....	....	....	....
Steam	Railroad cars	....	2	....	....	....	....	2
	Total	4	31	9	33	8	13	98

SOURCE; U. S. Bureau of Mines.

Diesel electric locomotive of the type commonly used in the iron mining industry.

electricity. This is due to the condition that electricity lends itself to maximum flexibility in the distribution of power from central power houses which presently supply the industry with over 10,000,000 kilowatt hours of the over 22,000,000 kilowatt hours consumed annually by the industry.

Practically all of the steel industry's privately owned electric generating plants use steam engines as the prime movers. However, sometimes one finds small stand-by diesel generating sets.

Turning now to diesel industrial locomotives we find that they have been steadily replacing steam locomotives for more than 20 years. These intraplant diesel locomotives range from 20-ton, 150-hp. to 80-ton, 500-hp.

A small plant which replaced its 55-ton steam locomotive with a 50-ton, 500-hp. diesel electric locomotive was pleasantly surprised when it found that the operation of the diesel locomotive resulted in an 85 per cent reduction in fuel costs, a 33 1/3 per cent decrease in crew wages, and an 87 per cent reduction in fueling time.

When a mid-western plant replaced three steam locomotives with one 50-ton and one 65-ton diesel electric it saved an average of $12.43 per hour in operating costs, including wages. The 50-ton diesel locomotive is used to switch furnace charging buggies and to haul industrial cars about the plant, while the 65-ton diesel electric locomotive is used primarily for switching incoming and outgoing railroad cars.

Another steel company saved $14.00 per hour in switching costs when it replaced one 80-ton and one 40-ton steam locomotive with two 65-ton diesel electric locomotives because of a saving of about 50 per cent in over-all operating costs.

In the steel industry locomotives are needed to haul from the stockpiles 35 to 40 regular freight cars of raw materials to fill a 1300-ton capacity blast furnace. In each tapping of a furnace of this capacity they must move 18 ladle cars with molten pig iron to the Bessemer converters, and 30 side-dump cars to move the slag to the dump.

These comparatively small but powerful locomotives haul ingot molds with molten Bessemer and Open Hearth steel to stripping machines, and glowing ingots from the stripping machines to the soaking pits. In addition to that they are needed in the transporting of semi-finished and finished steel products about the plants.

Diesel industrial locomotives are replacing steam locomotives because experience has shown that they are available over 90 per cent of the time. They are ready to start at a moments notice. Because they do not throw off dirty smoke they aid in reducing building maintenance costs. They reduce track maintenance costs because of their smooth even tractive effort, low axle loading and short wheel bases. They reduce labor costs because only one man is needed to operate a diesel industrial locomotive, as compared with two men on a comparable steam locomotive. Their stand-by costs are less than steam locomotives. And their fuel costs are about one third that of steam locomotives.

Diesel locomotive over-all operating costs can be reduced by compounding engines—using say two 150-hp. engines instead of one 300-hp. engine. With this compound power plant, if one engine fails there is still one which can function. Then too, if the load requirements are only half the maximum capacity of the locomotive, one engine can be shut down.

If maximum availability and low operating and maintenance costs are to be attained with diesel electric locomotives in steel plants then proper attention must be given to preventive maintenance.

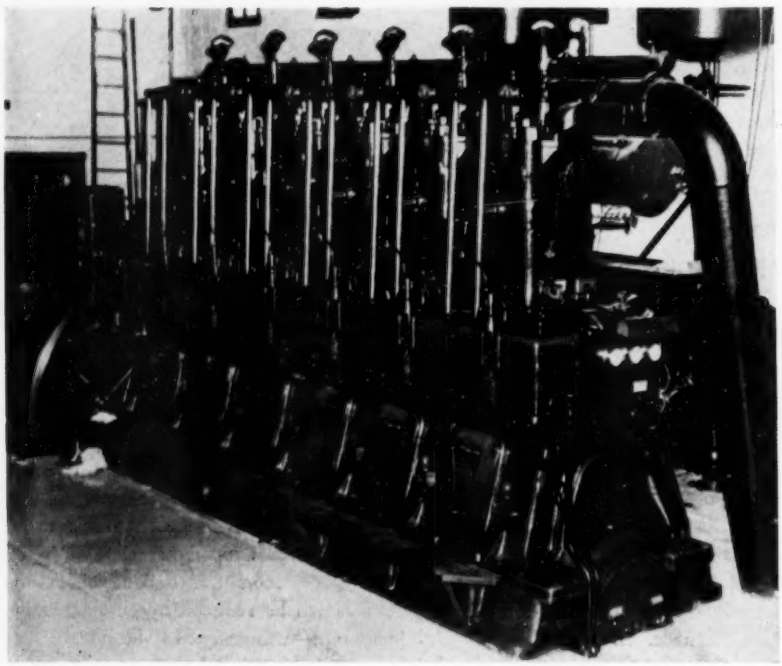
There must be a definite schedule of daily, weekly, monthly, quarterly, semi-annual and annual inspection and maintenance services as outlined by the engine builders and as operating conditions dictate.

Switching operating conditions in steel plants are not like those encountered in regular railroad switching because of the high content of dirt and dust in the atmosphere. This high content of foreign materials in the air affects the life and efficiency of intake valves, bearing surfaces and many other parts of locomotives. As a result

(*Continued on Page* 63)

Municipal Power at Shelbina, Missouri

by Fayette Weavery
Power Plant Superintendent



Installed in 1936, this Baldwin De La Vergne diesel has given nearly 15 years of service in the municipal power plant at Shelbina, Mo., and is now used for maintaining peak loads and for standby. The Model VG, six cylinder engine, with 15 inch bore and 18½ inch stroke, will deliver 480 hp. at 300 rpm.

MUNICIPAL electric power has a 56-year history in Shelbina, Missouri, a town of only 2000 inhabitants, located about 100 miles northwest of St. Louis. Shelbina, whose industries center around farm produce, particularly poultry, eggs, and feed, has gone through five phases in its power production. The latest phase, into which it recently was fully converted, was the modernization of diesel-electric power service with three more powerful, full diesel engines replacing the original two small semi-diesels and one full diesel unit.

The Municipal Light & Power plant of Shelbina came into being in 1894 and acquired a small steam generating set of unknown horsepower, which supplied direct current. Some time later alternating current was introduced with the purchase of a larger steam unit. When water and sewer systems were built in 1911, a new plant was built and a 165-hp. Corliss steam engine and 125-hp. slide valve engine were installed. This plant still houses the diesel power plant and water department.

Steam engines supplied all power until 1923 when finances and credit became so low that a car of coal could not be unloaded until all expenses on the car were paid. The Board of Aldermen then installed two 200-hp. semi-diesel engines which were paid for out of the difference between the cost of coal and fuel oil. The first full diesel engine, a 2-cyl. engine of 120 hp., was installed in 1932.

The 120-hp., 2-cyl. engine was the first to be replaced by a 6-cyl. diesel, of four times greater horsepower. This 6cyl. engine, a Baldwin De La Vergne, Model VG, was installed during the summer of 1936 and is still in use after 15 years of service. Continued growth of power demand after 1936 necessitated purchase of a 750-hp. engine to maintain safe capacity. This engine, a 6-cyl., 750-hp., 500-kw. Baldwin De La Vergne Model VM, replaced one of the 200-hp. semi-diesels in the spring of 1939.

The last of the original semi-diesels was replaced by the latest model Baldwin diesel, a series 700, 760-hp. engine. The three Baldwin engines now provide a total capacity of 1980 hp. or 1320 kw. The two 750-hp. engines are used alternately every other week and carry the base load. The 480-hp. unit is used together with one of the 750-hp. units for the peak loads. This schedule provides for an adequate maintenance program and assures un-

LIST OF PRINCIPAL EQUIPMENT ON LATEST ENGINE

Engine	Baldwin-Lima-Hamilton Corp.
Alternators	Westinghouse Electric Corp.
Air Intake Filter	American Air Filter Co.
Alarm Switches	Detroit Lubricator Co.
Auxiliary Lubricating Oil Pump	George D. Roper Corp.
Cooling Water Pumps	Fairbanks, Morse & Co.
Engine Lube Oil Pump	George D. Roper Corp.
Exhaust Snubber	Burgess-Manning Co.
Exciter	Westinghouse Electric Corp.
Fuel Filter	Commercial Filter Co.
Fuel Injection Pumps & Injectors	Bendix Scintilla
Fuel Oil Supply Pump	George D. Roper Corp.
Fuel Shut-Off Valve	Fulton Sylphon Co.
Gauges	U. S. Gauge Co.
Governor	Woodward Governor Co.
Lubricating Oil Strainer	Pyroltor Products Inc.
Lubricating Oil Cooler	Ross Heater & Mfg. Co.
Lubricating Oil Reclaimer	Hilco, The Hilliard Corp.
Pyrometer	Illinois Testing Laboratories Inc.
Water Cooling Tower	Ames

failing power in the event of an emergency shut down.

This power plant supplies the community and surrounding country with power and light requirements, and other industries in the community, which include two grain elevators, two grinding mills, a hatchery, and a 17-ton ice plant. The largest industry in Shelbina is the Producer's Produce Company, a co-operative organization which processes poultry and eggs.

All current for lighting the streets of Shelbina, the library, and all city offices is furnished without charge. This amounted to 300,000 kw. hr. during 1949. The Light and Water Department transfers to the general fund of the municipality from $18,000 to $20,000 each year.

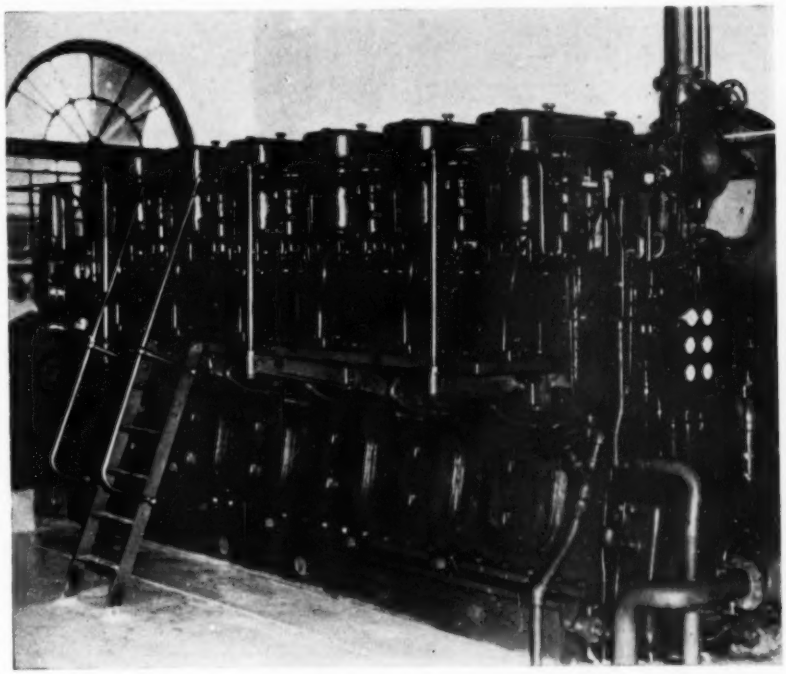
The increase in utilization of electric power in the Shelbina area is shown by the accompanying table. Total kilowatt-hours generated during 1949, approaching 2,500,000 kw. hr., showed 100 per cent increase in 10 years and 400 per cent increase since 1932. Street lighting, which required 20 to 25 per cent of the power generated during the early 1930's, now takes twice as many kw. hr., but was only 1/8 of the total generated in 1949.

After the installation of the first two Baldwin units, the cost per kw. hr. was progressively reduced from 1.90 cents to 1.23 cents, until 1944 when subsequent increases in costs were brought about by the rising cost of fuel and lubricants and general post-war inflation. This brought the cost up to 2 cents per kw. hr. Upon installation of the latest Baldwin engine, cost reductions were again reflected and the present cost per kw. hr. is 1.84 cents. It should be noted from the tabulation chart that the engine is operated at an average load of only 275 kw. This average load is only about half the full load rating of the 500 kw. During peak periods the engine operates at its full load rating.

Engine accessories include an enclosed water cooling system with a forced draft cooling tower with coils of 2400-hp. capacity and space for additional coils with 1000-hp capacity. All engines are interconnected to this system so that a 400 gpm. pump furnishes cooling water to all engines or to one as needed. Cooling water is softened by zeolite and is further treated with chromite.

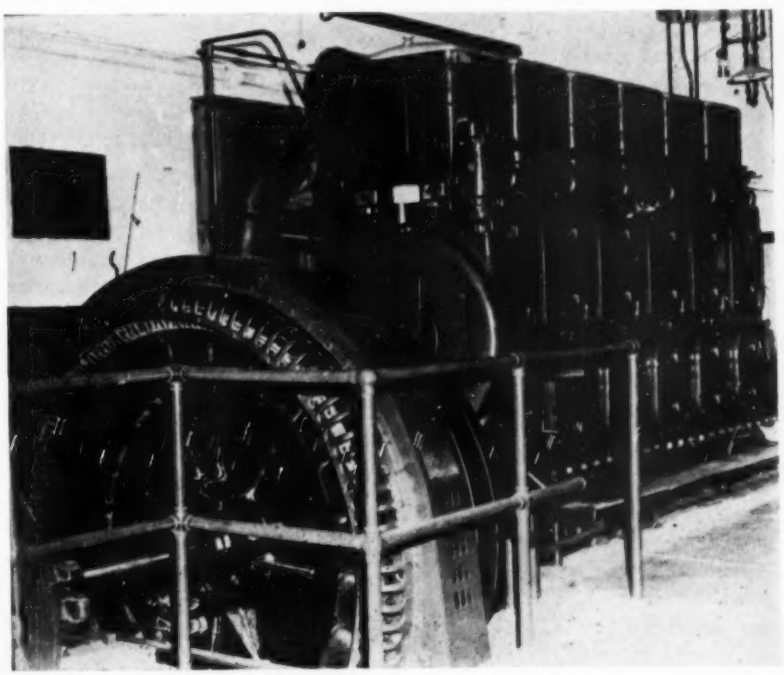
Compressed air is used for starting all engines. Two air tanks with 250-psi pressure and four with 180-psi. pressure are supplied by a 2-stage high pressure air compressor and a 2-cyl. low pressure air compressor, both motor driven. The lower pressure air is used mainly for blowing a large whistle morning, noon and evening.

Each engine is equipped with a set of lubricating oil strainers and the oil is kept in good condition by an oil reclaimer of the Fullers earth batch



Above—Most recent addition is a Baldwin, Series 700, diesel engine of 750 hp. at 300 rpm.

Below—The second Baldwin diesel installed in the plant is a Model VM of 750 hp. at 327 rpm.



Power Record of the Light and Water Department
Shelbina, Missouri

Year	KWH	Fuel Gallons	KWH per gal.	Av. Load KW	Peak Load	Operating Costs	Cost per KWH	City Lights KWH	%	Year
1949	2,404,236	209,585	11.47	274.5	580	$44,388	1.84¢	301,119	12.5	1949
1948	2,220,800	193,944	11.45	253.5	550	45,710	2.06	290,594	13.1	1948
1947	2,054,000	181,459	11.32	237.9	530	41,063	2.00	261,255	12.7	1947
1946	1,749,000	161,625	10.82	199.6	460	31,390	1.79	215,680	12.3	1946
1945	1,754,300	161,332	10.88	200.5	410	22,642	1.29	208,283	11.9	1945
1944	1,769,500	163,659	10.81	201.4	380	21,715	1.23	210,933	11.9	1944
1943	1,566,100	150,974	10.37	178.3	400	20,252	1.29	215,941	13.8	1943
1942	1,364,800	138,736	9.84	154.7	360	20,318	1.49	220,906	16.2	1942
1941	1,350,600	137,266	9.83	153.7	350	19,577	1.59	221,867	16.4	1941
1940	1,225,000	134,522	9.11	139.6	360	18,314	1.49	217,115	17.7	1940
1939	1,204,300	134,245	8.97	137.1	360	18,750	1.56	253,489	21.0	1939
1938	1,105,800	128,308	8.61	126.0	340	15,870	1.44	252,397	22.8	1938
1937	1,039,000	124,405	8.30	118.5	290	16,044	1.54	241,879	23.3	1937
1936	998,800	120,577	8.28	113.5	280	17,408	1.74	208,098	20.9	1936
1935	778,200	99,346	7.83	89.4	240	14,747	1.90	146,354	18.8	1935
1934	776,900	91,429	8.40	88.7	250	11,101	1.43	152,291	19.6	1934
1933	658,600	75,868	8.68	75.1	200	13,212	2.00	150,651	22.9	1933
1932	567,900	68,331	8.31	64.5	190	13,590	2.38	140,014	24.6	1932

type. The reclaimer is used continuously for 48 hours per week, taking the oil from the engines, through the reclaimer, and back to the engines. The oil thus gives maximum service. Manifolding permits the use of the reclaimer on any one of these engines.

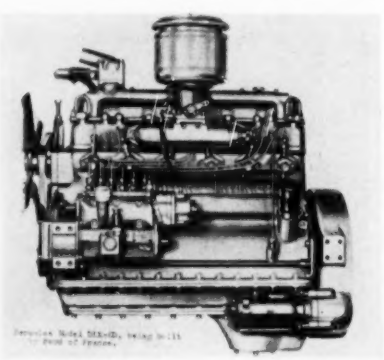
Conventional protective devices are used on each engine; low pressure alarm and shut down for lubricating oil, high temperature alarm and shut down, and over-speed stop.

The City of Shelbina, Mo., can be proud of its municipal power plant. Housed in a modern building, all diesel installation makes an efficient plant with ample capacity to care for the city's needs for power and light.

Ford of France Builds Hercules Diesels

It was recently announced by Ford of France that the Ford truck built there is now available with a Ford-Hercules diesel engine. The engine, the Model DIX-6D—6cyl., high-speed, heavy duty diesel with a piston displacement of 248 cu. in., and which develops 93 hp. at 3000 rpm., is being manufactured by Ford of France under an agreement with Hercules Motors Corporation. It is an optional power plant for Ford 6- and 8-cyl. gasoline engines.

With economic conditions a decided obstacle to the favorable exporting of many products to Europe, many manufacturing companies have established branches at strategic points in European countries to serve as assembly plants and also to merchandise the finished products. Ford of France is typical. It has been building complete Ford passenger cars and trucks for many years at Possy, near Paris, to serve France and her colonies primarily. It was early in 1949 that they began tooling up to produce the Hercules Model DIX-6D diesel engine. This model is identical with the DIX-6D built by Hercules.



In 1937, when Ford first started to offer its trucks and school buses abroad with Hercules diesel engines as optional equipment, many thousands of chassis were shipped to foreign countries equipped with Model DOOD 4-cyl. units. In 1948 replacement by DIX-6D 6-cyl. units was made.

Washington Slant

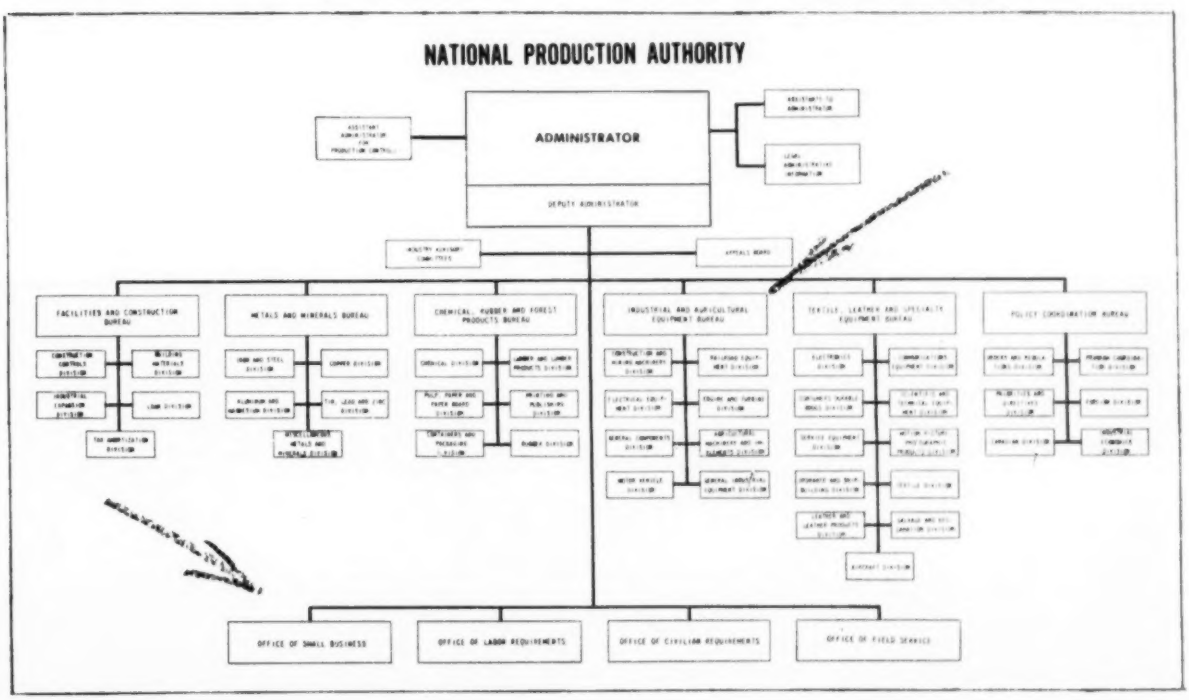
ORGANIZATION CHART OF NPA is given below. Most of diesel industry will have contact with Divisions in Industrial and Agricultural Equipment Bureau; many can get help in the Office of Small Business. Handy reference booklet is "Defense Mobilization Organization" compiled by Joint Committee on Defense Production. Published May 4, 1951, it gives chain of command, brief outline of functions, personnel and telephone numbers.

FIELD CHECK ON MATERIALS SITUATION shows spotty situation. In most cases, bulk of needed materials are obtainable with rough going in getting a needed critical item. Example—Row of piston pin fitting machines held up for lack of a handfull of a special heavy material. In other cases, production is being maintained at the expense of inventory. Some are doing O.K.

FULL IMPACT OF REARMAMENT has not been felt yet. This is a conversion period for production as well as for controls. Tanks, for example, are not really rolling out as they will be later. Tip-off is in recent tightening of some uses of CMP materials. Rated orders are getting greater priority through "set-asides". To give the idea, producers of iron and steel castings are required to reserve for rated orders higher percentages in the third quarter; steel castings went from 20 to 75 and 80 per cent, iron castings went from 20 to 75 and 80 per cent, depending on type.

LOCOMOTIVE PRODUCTION for the third quarter is scheduled at 250. Priority assistance was extended to builders (as for farm and mining machinery, industrial components, etc.) as an interim assist pending full operation of CMP. Alco, Baldwin-Lima-Hamilton, F-M, and EMD were authorized DO's. Percentage-wise, they get 23.5, 12.9, 4.2 and 59.4 per cent, respectively, of the program involving 79,000 ton-carbon steel, 14,000 ton-alloy steel, 12,250,000 lb.-copper, and 2,400,000 lb.- aluminum in the month of July. Production base was '48, '49 and '50 as usual base period (first half of '50) did not follow historical pattern.

MATERIALS FOR LABORATORY USE can be obtained under M-71. Small quantities (defined in the order) can be certified as provided and the allotment symbol "X1" used. Necessary Class A products can be similarly obtained but the controlled materials used in their manufacture plus direct materials cannot exceed the "small allowance" quota. For larger allotments, labs can apply to NPA on form NPAF-109, in triplicate.



Some background for the controversy of

LPG Engines Versus Diesels

*by Leonard Raymond**

Interest in the use of liquid petroleum gases (LPG) as a fuel for engines in vehicles has been increasing. This trend was brought into focus when it was announced that the Chicago Transit Authority had ordered 500 buses powered by spark ignition engines.

Various glowing accounts of the economy that could be achieved through the use of these fuels inspired an editorial project to evaluate the possibilities for the purpose of objectively reporting the finding to our readers and to determine what impact, if any, would be felt in the diesel industry.

To this end, various agencies, both inside and outside of the diesel industry were contacted to get both sides of the picture. When the answers began to come in, it was obvious that many parallel projects were under way and that considerable data was already correlated.

As a start on the subject, we felt that we could do no better than to present an abstract of the paper entitled "Liquified Petroleum Gas as a Fuel for Automotive Vehicles", presented by the author, a member of the Research and Development Dept., Socony-Vacuum Oil Company, at the National Fuels and Lubricants Meeting of the Society of Automotive Engineers.

Subject matter for this article was selected for the purpose of providing the necessary background before entering (in a future issue) into the technical and cost comparisons. The LPG side is presented and where pertinent the reader, from his knowledge of diesel practices, can make the necessary comparisons.

LIQUIFIED petroleum gas, or LPG, has been attracting considerable interest in recent months in the bus industry. Several factors are responsible for this interest, and they seem to have been timed so as to bring their weight to bear jointly on this problem.

First, management in the bus industry is increasingly aware of the serious position since the war, in the squeeze between rising labor and other costs and a fairly rigid fare structure.

Secondly, there is an increased supply of LPG. Several factors are primarily responsible, one being the expanded production, chiefly in the Southwest oil and gas fields, and another, the displacement of LPG by natural gas. In addition to this, the increased production of natural gas has been accompanied by increased supply of by-product LPG from natural gas processing.

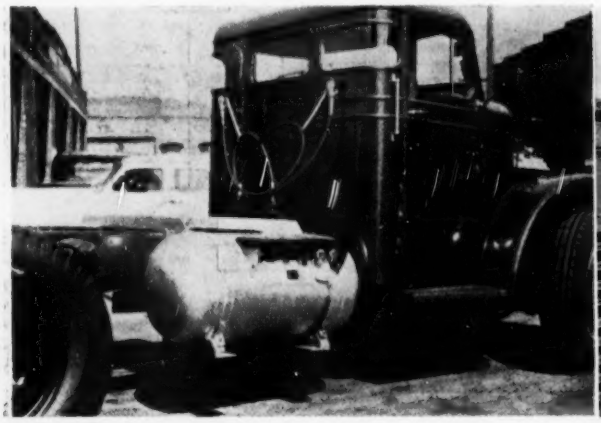
The final item is the availability of engines of higher compression ratio to use high octane number propane and butane.. This is of considerable importance from the standpoint of improving the fuel economy with these lower heat content hydrocarbons.

*Socony-Vacuum Laboratories (A Division of Socony-Vacuum Oil Co., Inc.). Research and Development Department.

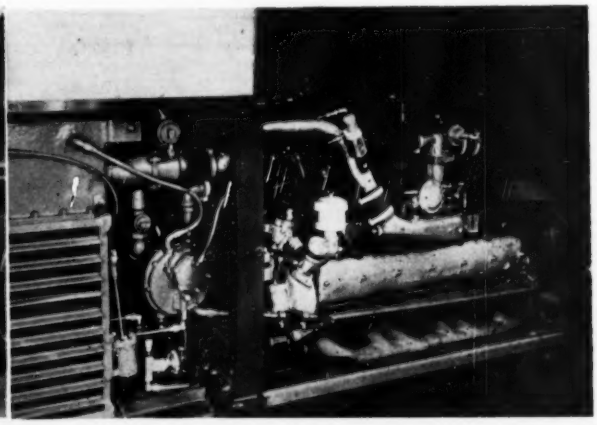
Nature and Properties of LPG

Materials defined by LPG include propane, propylene, normal and isobutane, and butylenes. These are all known as hydrocarbons, being compounds of hydrogen and carbon. Butane is a normal component of gasoline and is added to improve starting through increased volatility. Only limited amounts of butane are permissible because an excess would cause vapor lock. Propane is lighter and much more volatile than butane, and for a given vapor pressure, much less of it

LPG Fuel Tank on Truck Chasis.



Twin Coach LPG Installation.



can be incorporated in gasoline than of butane.

Fundamentally, propane and butane do not differ from other motor fuel components since, in general, all are hydrocarbons of one type or another and will form combustible mixtures with air or oxygen with release of large amounts of energy on ignition.

Some of the principal properties of pure propane and butane are listed in the Table I together with data on average commercial products. It should be noted that these materials are known as Liquefied Petroleum Gases because while gaseous at normal temperatures and pressures, they liquefy rather easily under pressure. Thus, while propane will boil or vaporize at —44° F at atmospheric pressure, at 100 psig. it is a liquid at + 60° F.

TABLE I

Principal Properties of

Propane and Butane

	Propane	n-Butane	Commercial Propane	Commercial Butane
Boiling Point, °F, 760 mm Hg	-44	+31	-51*	+15*
Freezing Point, °F, 760 mm Hg	-306	-217		
Specific Gravity, liquid 60/60	.5077	.5844	.509	.582
Specific Gravity of Gas, 60°F, 760 mm	1.5222	2.0065	1.52	2.01
Weight, lb/gal	4.223	4.863	4.24	4.84
Btu/lb, gross	21,490	21,134	21,560**	21,130**
Btu/gal, gross	90,752	102,774	91,500**	102,600**
Air required for combustion, lb air/lb fuel	15.65	15.43	15.58	15.3
cu.ft. air/cu.ft. fuel	23.82	30.97	23.4	30.0
Inflammability limits, vol. % in air mixture	2.37-9.50	1.86-8.41	2.4-9.6	1.9-8.6
Vapor Pressure, psig, @ 60°F,	92	12		
@ 100°F	174	37	192	59
@ 130°F			286	97
Octane Number, Motor	100	92		
Octane Number, Research	100+	95		

* Initial Boiling Point
** After Vaporization

The composition and properties of the commercial products will depend upon the source, the products from gasoline and recycling plants containing only the saturated normal and isoparaffins whereas the refinery production will contain appreciable quantities of unsaturated or olefinic hydrocarbons such as propylene or butylene. In addition, the particular blend used for LPG will depend on the supplier, the locality and climatic conditions. The LPG may be essentially 100 per cent propane or butane or mixtures of the two.

The milder climates as in California will permit greater percentages of butane in LPG blends than the colder sections of the country. In California it is possible that relatively more butane in LPG may be available for LPG use because of the lower Reid vapor pressure of gasoline permissible for freedom from vapor lock.

Thus, LPG blends in California may consist of as much as 70 per cent butane and 30 per cent propane. On the other hand, in the Northeastern section of the country with its colder temperatures and with other means of disposing of the butanes, LPG in most cases is commercial propane conforming to the specifications of the Natural Gasoline Association of America.

Where refinery processing is the source of commercial propane, as in the Northeast, the product generally contains appreciable quantities of propylene, one analysis showing approximately equal percentages of almost 50 per cent each of propylene and propane with small amounts of ethane, ethylene, butane and butylene. The vapor pressure of the commercial propane shown in Table I is somewhat higher than the pure propane due to the presence of small amounts of the more volatile ethane and ethylene.

Both propane and butane are essentially odorless. Since they are flammable products, a large number of states and municipalities have specified that an odorant be added in accordance with the standards of the National Fire Protection Association to permit the vapor which is heavier than air to be readily detected in case of a leak.

Common odorants used in LPG in the past several years are sulfur compounds of the mercaptan type such as ethyl or isopropyl mercaptan. A concentration of one lb. per 10,000 gal. of LPG produces a faint but unmistakable "Degree II" odor when 1.5 per cent LPG is present in air, this concentration being approximately 1/5 of the lower explosive limit of 2.4 per cent for propane.

Sources of LPG

The principal sources of LPG are (1) crude oil wells, (2) natural gas wells, (3) gas distillate wells, and (4) refinery operations. In the early days of the oil industry, before the producers realized the value of the by-products in the casing-head gases and before means to separate and recover the liquefiable products had been developed, the gases rising to the well or casing-head with the crude oil were considered a necessary evil and were vented to the atmosphere and flared or burned. In more recent years, the pressure of competition and also growing attempts to conserve our valuable natural resources have lent emphasis to the maximum recovery of hydrocarbon products from all oil field and refinery operations.

Both crude oil and natural gas are under high pressure in underground formations. In the case of crude oil production, a mixture of crude oil and wet gas rises to the surface through the well tubing. The oil well or casing-head gases are separated from the crude oil at a gas trap. The crude oil passes to a storage tank while the wet gas goes to either a gasoline or a recycling plant. Both plants strip or recover the liquefiable components, the products including LPG, natural gasoline and finished motor gasoline.

While natural gas liquids from casing-head production are regulated by oil well or crude oil proration, there is little or no restriction on gas production up to the present time. The Texas Railroad Commission,

TABLE II

Domestic Sales of Liquefied Petroleum Gases (bbls. daily) (*)

	1947	1948	1949 (preliminary)	1950 (forecast)
Home uses	75,050	95,840	103,430	112,800
Gas manufacturers	11,050	15,460	15,000	14,500
Industrial fuel	11,320	13,980	15,000	16,000
Chemical industries	40,170	43,960	45,000	46,000
Internal-combustion engines (all applications)	6,510	6,050	5,500	5,500
Unaccounted for	280	160	200	200
Total	144,380	175,450	184,130	195,000

(*) Oil and Gas Journal, January 26, 1950, p. 199

which is the regulatory body in that state, has been active in issuing stop-flaring orders, which in effect have meant either a stoppage of crude oil production or construction of gasoline plants to recover the natural gas liquids.

In refinery operation, approximately 10 per cent of the crude charge is represented by the propane-butane or C_3-C_4 cut, about 2/3's being butane-butenes and 1/3 propane-propene. The bulk of the C_4 (butane-butylene) fraction is used in motor fuel, either directly or by conversion. The propylene is used to a lesser extent for polymerization to motor fuel. Propane is the chief source of LPG from the refinery. Some propane is used as refinery fuel, but all could be recovered for use as LPG if the price were attractive.

Demand and Availability of LPG

Some figures on the domestic sales of LPG for all purposes may be of interest and are given in Table II.

The over-all sales of LPG have shown a phenomenal expansion since 1940, the increase being over ten-fold. In the same time, LPG for automotive use has not quite doubled in volume and, as the data shows, has actually declined in volume since 1947. At the present time, LPG for automotive use is roughly 3 per cent of total LPG sales. Figures for motor and diesel fuel consumption in trucks and buses are shown in Table III.

The potential availability of LPG is much greater than the sales total shown in the first table, a potential of 250 to 350 million bbl. per year or 10-15 billion gal. per year from natural gas and cycling plant production being estimated in comparison with the approximate sales of 3 billion gal. forecast for 1950. An additional large volume of LPG is potentially available from refineries which are estimated to have supplied 1 billion of the 3 billion gal. sold in 1949. A very large proportion of the refinery production is now applied to other uses, including motor fuel production as a major item.

However, it should be realized that other factors besides abundance affect the market position and acceptance of a raw material, cost of transportation being a key item, as has been the case in a number of large volume industries. Thus, the Baltimore-Philadelphia-New York harbor area handles an estimated 400,000,000 gal. (10,000,000 bbls. approximately) of LPG per year, although the automotive demand for this product on the East Coast is virtually non-existent, price undoubtedly being a deterrent. Of this quantity, about one-half is supplied by refineries, the remainder coming in by tank car and one pressure tanker.

History of LPG-Powered Vehicles

Application of LPG to automotive use dates back to the early thirties when the first conversions to LPG were made in heavy trucks, off the road vehicles, rail cars and industrial engines, principally on the West Coast. The growth since that time has been spotty, LPG moving in and out of operations for a variety of reasons. One bus operation in Spokane used LPG powered equipment for over 10 years, including as many as 133 coaches, but these units eventually were replaced by other coaches several years ago, following a change in ownership and policy.

The Steel Industry Needs Scrap—
Keep it Moving

The largest use of LPG in internal combustion engines is in the state of California where it has been estimated that 2000 trucks and 20,000 units of farm and highway construction equipment use one-third of the total LPG consumed in the United States by internal combustion engines. A number of petroleum companies on the West Coast, including General Petroleum, have tried to promote the use of LPG in automotive eqiupment for the past 15 years with indifferent success.

Erratic changes in supply, demand and price undoubtedly have affected LPG acceptance, the change in price from 4¢ per gal. to 8¢ per gal. about two years ago apparently causing a serious setback. In addition, the entry of higher-powered diesel engines has also had its effect on interest in LPG as a motor fuel.

One supplier estimates that the consumer will have to be able to buy propane for three-quarters the price of gasoline to break even with gasoline. Since price is the major factor affecting the attractiveness of LPG in any area, the decision of any operator considering change to LPG powered equipment undoubtedly would be influenced to a considerable extent by the stability of the price differential between gasoline and propane.

The stability of the price structure will vary with different sections of the country, those areas within easy reach of the producing fields undoubtedly being assured of a low and more stable price than the more remote industrial areas. As an example, in the Southwest and Middle West states surrounding the producing areas, LPG is expected to make considerable inroads in the farm tractor field. A number of LPG suppliers are

promoting LPG application in this field including some of the companies which are in undersupply on the East Coast.

It has been estimated by one company that 30,000 tractors will be converted to LPG this year. Since this is a summertime demand, it will be valuable in helping level off the LPG industry's sales curve, hence its importance. Many of the farms in question use bottled gas for heating and other purposes, so the change to LPG may be somewhat easier than in other conversions.

Transportation

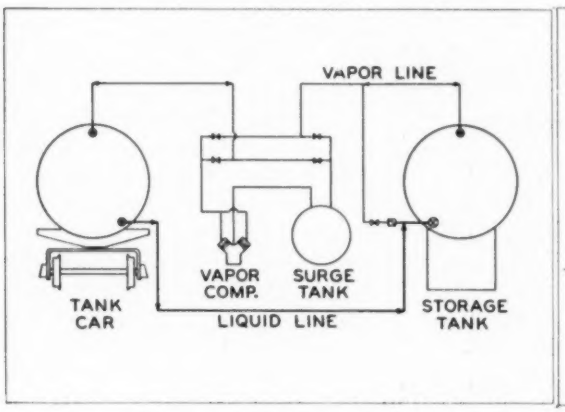
Within the past 20 years, high pressure tank cars and tank trucks have been developed to replace the 20-300-lb. "bottled gas" cylinders for transportation of LPG. Bulk shipments now are made in 8000-12,000-gal. tank cars and 3000-8000-gal. tank trucks from the producing area or refinery to the bulk plants, at which points storage tanks with maximum capacity of 30,000 gal. are used.

While a greater part of the transportation is by tank car and tank truck, one company is using a 35,000-bbl. (1,470,000-gal.) capacity tanker which is converted Type CIA dry cargo ship containing 80 high pressure cylindrical tanks designed specifically to transport LPG. This tanker is said to be making two trips per month from the Gulf Coast to the New York area. The same company has a bulk terminal of 2,500,000 gal. capacity in the New York harbor area.

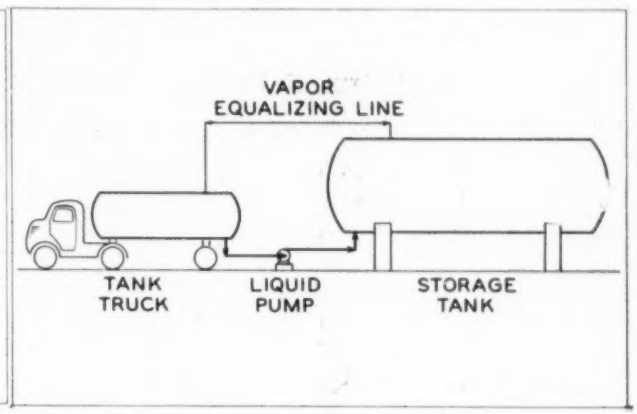
Although there has been some talk of moving LPG by pipeline, particularly in the Mid-West where large amounts of butanes are transported in this manner for motor fuel blending, little propane is being so moved due to lack of propane storage facilities and to the overloaded condition of the pipelines.

Method of Delivery to Storage Tank

Transfer of LPG from a tank car or tank truck to a storage tank is made by one of several methods, all involving a closed system of pressure: (a) liquid pipe, (b) vapor compressor, (c) air or gas pressure, (d) gravity. The first two systems are the most frequently used and are illustrated.

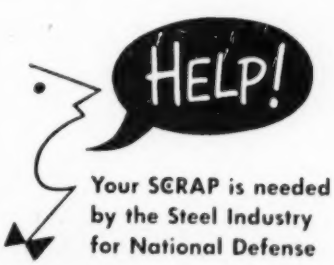


Vapor compressor transfer system.



Liquid pump transfer system.

The chief source of safety regulations for handling LPG is Pamphlet No. 58 of the National Board of Fire Underwriters (NBFU). Pamphlet No. 58 specifies that "All transfer of LPG shall be by means of approved pumps or compressors. When compressors are used they shall normally take suction from the vapor space of the container being filled and discharge to the vapor space".



If hose is used in the transfer lines it must be resistant to the action of liquefied petroleum gases and if subject to container pressure, shall be designed for a bursting pressure at least 5 times the designed container pressure. Hose connections must be capable of withstanding twice the designed container pressure.

Pipe or tubing also may be used and valves and fittings specially designed for LPG are available. Safety devices such as relief valves and shut-off valves are closely specified and generally must be approved for use with LPG. Special liquid gauging devices also are specified, together with excess flow valves.

All electrical connections must be in strict accordance with the requirements of the National Electrical Code for Class I, Group D, Hazardous Locations.

Pamphlet No. 58 indicates the factors that must be considered in the location of the tank car unloading points and specifies that the car wheels must be blocked at both ends to prevent movement and a man must be in attendance at all times during the unloading.

Operators' Storage and Dispensing Facilities

Operators' storage facilities, according to Pamphlet No. 58, can be either above or below ground. Above ground storage is preferred to under ground because of lessened external corrosion, reduced cost and ease of inspection. Vapor lock can also be a big

problem in underground storage unless there is a gravity feed to the liquid pump. In the case of storage tanks of over 1200-gal. capacity, the minimum distance from the nearest important building or line or adjoining property is 50 ft.

Tanks or containers must be constructed and tested in accordance with the ASME Unfired Pressure Vessel Code or with the APE-ASME Code. The storage tanks must meet the same requirements as to piping, tubing, hose and fittings as mentioned previously. The per cent filling capacity is rigidly specified to avoid difficulties and failures due to excessive pressure build-up. Storage containers or tanks for products with vapor pressure between 175 and 200 psig. at 100° F (commercial propane falls within this range) must have a minimum design working pressure under the API-ASME Code of 250 psig. which is equivalent to a hydrostatic test of 1000 lbs.

The shell of head thickness of any container must not be less than 3/16 in. and the size of the tank is limited to 30,000 gal. The method of mounting and supporting is described together with the means for protecting valves and other accessories against tampering and mechanical damage. Tanks above 1200-gal. water capacity must be electrically grounded and suitable fire protection facilities and other precautions observed.

The dispensing equipment to fuel the tank on the vehicle consists in substance of a liquid pump, a meter, a special dispensing nozzle and a vapor line connection. Pumps of up to 20-gpm. capacity are available, the pump building up a differential pressure according to the setting of the differential valve, which may be as high as 30 lbs.

Safety and Legal Considerations

The safety and legal aspects of LPG have occasioned much discussion. According to reliable reports, 37 states, mostly Western and Mid-western, have legal codes regarding LPG and permitting its use subject to regulations based in the main on NBFU Pamphlet No. 58. The State of New Jersey has very recently passed a bill authorizing the Division of State Police to prescribe uniform state regulations for all phases of LPG storage, handling, transportation and use. Here again, the published standards and recommendations of the National Fire Protection Association will be used as a guide. In these states and in others not having such regulations, local ordinances have been passed concerning LPG use.

Before discussing some of the regulations it should be pointed out that the safety record of the LPG industry is regarded as a good one, although fires and explosions have occurred with LPG equipment and facilities in automotive applications, both in this country and abroad. Some of these were due to faulty installation, while others undoubtedly were due to carelessness or to ignorance of the nature of LPG.

Some prejudice against LPG exists because of these accidents and also due to its ease and rapidity of vaporization in case of a leak. Its much higher volatility and the rapid, potential formation of explosive mixtures is the chief reason why LPG is considered more hazardous than gasoline. The hazards should be considerably reduced if modern, approved equipment and extra installation features are employed, and additional care in handling a flammable material under pressure is exercised.

The Association of Casualty and Surety Companies has issued a series of 8 pamphlets dealing with the safe use of liquefied petroleum gas and the Factory Insurance Association has issued a pamphlet on "Recommended Good Practice for the Storage and Handling of Liquefied Petroleum Fuel Gas".

The pamphlets stress the fact that LPG "expands very rapidly when released to the atmosphere and, being extremely flammable, every effort should be made to eliminate the possibility of leaks by the use of suitable equipment and proper maintenance and operation of automotive vehicles. In spite of these precautionary measures, if a leak does occur the consequences could be very serious because the gas is under pressure in the entire system".

Among the safety features considered very desirable in automotive applications is the Parkhill-Wade type of safety tank with its built-in outage tank and the safety type of fuel nozzle. Also a positive lock-off such as used in the Algas and Century carburetor systems, in which the gas pressure tends to close the regulator, is a means of reducing the possibility of gas leakage when the engine is stopped. Care must be taken when servicing the converter or carburetor to make certain that fuel is shut off.

An engine should never be started if there are any signs of a leak of the LPG. If a leak should occur, necessary precautions should be taken to guard against any source of ignition. In case of an LPG fire, it generally should not be extinguished but should be controlled until the leak can be shut off at its source. If the flame should be extinguished without stopping the leak, the gas-air mixture might ignite explosively or in a flash explosion,

TABLE III

Fuels Consumed, by Highway Vehicles (bbls. daily) (**)

Motor Fuel	1948	1949 (preliminary)	1950 (forecast)
Trucks	528,570	558,640	582,500
Buses	40,600	39,660	39,500
Total Motor Fuel	569,170	598,300	622,000
Diesel Fuel			
Trucks	3,320	4,310	5,880
Buses	10,940	13,080	15,190
Total Diesel Fuel	14,260	17,390	21,070

(**) Oil and Gas Journal, January 26, 1950, p. 198

causing considerable damage and injury.

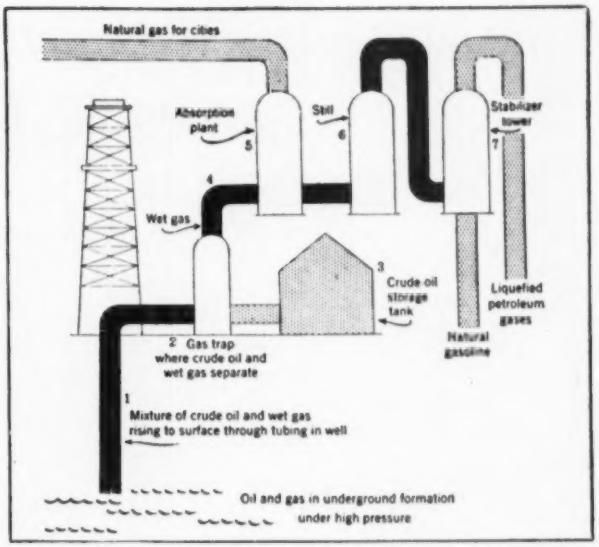
Although there apparently are no federal or state regulations barring LPG in buses, the Fire Marshals of individual cities generally have jurisdiction over such use. Some cities, like Cleveland which had a disastrous natural gas explosion and fire some years ago, have barred the storage of LPG within the city limits. The city of San Francisco does not allow the storing or dispensing of LPG inside the city.

On the other hand, Los Angeles and other California cities permit the handling of LPG within the city limits, but under drastic regulations. Some cities have departed from Pamphlet No. 58's recommendation of a minimum distance of 50 ft. between the LPG storage tank and the nearest building by increasing the distance to 100 ft.

As a result of the chemical explosion in the Holland Tunnel last spring, both New Jersey and New York have passed bills establishing more stringent penalties for the violation of the regulations regarding the bridges and tunnels operated by the Port of New York Authority. Section 8 prohibits the transportation of explosives, inflammable or combustible liquids, including gasoline, hazardous or poisonous materials, or any compressed gas.

The Port of New York Authority, in addition, has specifically prohibited LPG transportation, or movement of LPG powered vehicles, through tunnels under its jurisdiction. Also, LPG buses will be excluded from New York's new bus terminal. There is no prohibition against the movement of LPG vehicles over the Port Authority's bridges. It has been explained by the Chief of the Office of Safety of the Port Authority that the move was taken to protect the public, due to the confined space of the tunnels and the difficulties in fire fighting. No change is expected until New York and New Jersey state regulatory laws are passed, and even then the Port Authority may not rescind its prohibitions unless it becomes convinced LPG is safe.

With regard to insurance, rates on vehicles and on storage facilities



Separation of LPG from Crude Oil and Natural Gas.

are handled by two different agencies. On vehicles, the National Automobile Underwriters Association, which sets rates nationally for all companies in its Association, has reported that the subject of rates for LPG-powered vehicles has been under study for a year and a half and is still being studied.

At present there is no differential in rates fom gasoline-powered equipment. It was emphasized that LPG presents an added hazard if not controlled, most LPG fires or explosions being bad ones, and that carefully engineered, maintained and operated vehicle conversions are essential.

With respect to garage and fuel storage insurance rates, the Fire Insurance Rating Organization of New Jersey stated that there has been no previous inquiry on use of LPG as a bus fuel and no local utilities have raised decision on whether LPG changes the hazard and did not know if there would be an increase in hazard without examining a specific case.

The opinion was expressed that in the light of modern knowledge, the conversion of garages to LPG storage and handling facilities could be safely made, but "that any conversion to LPG which did not comply with current standards would, undoubtedly, result in an increase in rate". It was pointed out that above-ground storage tanks are recommended for LPG and if properly installed, the storage rate should be about the same as for above-ground gasoline tanks. This rate, however, is double that for underground gasoline storage.

Conclusions

1. Potential availability of LPG on a national basis will continue to be far in excess of projected demand for some years, the chief source of supply being the crude and gas well production region of the Southwest.

2. The growth of automotive use of LPG nationwide has been erratic, a slight decline in volume occuring in the last two years.

3. LPG installations, including engine, storage, dispensing and ventilating equipment, cost considerably more than gasoline facilities.

4. Delivered price of LPG from the Southwest production fields varies with locality, transportation being a major item of cost to the highly industrialized areas. In the East, where refinery propane appears to be lower in cost than material from the Southwest, the supply of this lower cost material is limited.

5. Any system under pressure with highly volatile fuel is basically less safe than gasoline, and some local authorities have prohibited the storage, transportation and use of LPG. With approved equipment and extra installation features and with additional care in use and servicing, the safety record probably could be as good as gasoline.

Some Interesting Experiments with
Bi-Metallic Piston Skirts

This is a sort of "Man Bites Dog" story. Much attention has been focused in recent years on the problem of molecularly bonding cast iron piston ring carriers to aluminum pistons. Here is a switch; molecularly bonding aluminum to a cast iron piston skirt.

SOMETHING new in pistons—skirts with an ⅛ in. thickness of aluminum bonded the full length of the cast iron trunk—is improving the performance of some large diesel engines in the biggest municipally-owned diesel generating plant in the U. S. They are helping to improve the electric light and power service in the community of Freeport, Long Island, N. Y.

The brain-child of Thomas Moore, the plant's chief engineer, the new pistons have been thoroughly tested in one of the plant's seven big diesels and have proved so satisfactory that their use in the other six engines is planned. In an engine where cast iron piston failures were bothersome and a major cause of down-time, the new bi-metallic pistons have resulted in a nearly 100 per cent availability record and have, to date, completely eliminated piston seizure as a cause of shutdown. This is despite the fact that the engine ran at overloads as high as 30 per cent for periods of 10 minutes or more at a time during last November's big windstorm when powerlines were blown down and shorted in pools of water causing 3000 kw. power surges.

The aluminum clad pistons were made for Mr. Moore by Arthur Tickle Engineering Works, of Brooklyn. The aluminum is molecularly bonded to the cast iron of the skirts through use of the Al-Fin process—a method of joining aluminum and its alloys to iron or steel. The Tickle company holds a license to use the patented process which was developed by the Fairchild Engine and Airplane Corporation for the construction of bi-metallic aircraft cylinder barrels.

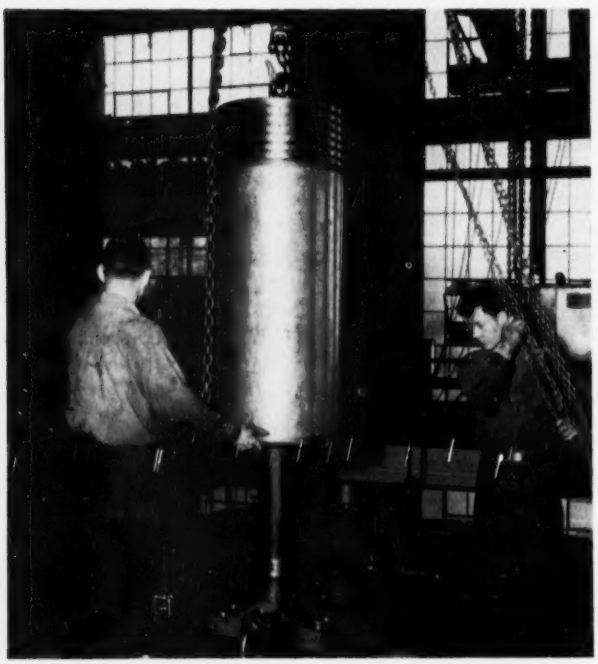
Installed in the Freeport plant's No. 9 engine the new pistons have enabled Mr. Moore to considerably improve the record of availability on this engine. The engine is a trunk piston type, rated 3960 hp. at 240 rpm. The bore is 20½ in.; stroke is 27½ in. The piston skirt is 41 in. long.

The bonded aluminum extends the full length of the trunk, starting at the point of head attachment and is feathered off in the last inch or two. Since aluminum has excellent bearing qualities, the entire skirt is virtually one large bearing. In addition, due to aluminum's superior heat dissipating ability, the danger of formation of local hot spots, which would break the lubricating film, is alleviated. The embeddability characteristic of aluminum, in comparison to cast iron, has already been credited with saving a shut-down on the engine.

One piston, removed from the engine after about 1500 hr. of operation because of an oil leak between the piston head and trunk, proved this. After removal, a long score, running the full length of the piston from the top of the trunk to the very bottom, was noted. From examination, it was evident that some hard particle had been caught between the piston and the wall. No evidence of malfunction had been noted and examination of the cylinder liner wall showed it to be undamaged. The piston was still 100 per cent serviceable and has now a total of about 2617 hours of operation.

Mr. Moore, from his many years of experience with the engine, calculates that he'd certainly have had an engine failure and very likely an engine fire if the hard particle had come between a conventional cast iron piston and cylinder wall. The imbeddability of aluminum permitted the particle to work its way down the piston skirt and drop harmlessly into the crankcase.

Further proof of the advantage of



Lowering an aluminum clad piston in engine to check skirt clearance before installation in engine at the Freeport, L. I. plant.

the aluminum surfaced piston skirts was given later on this same engine. An exhaust port fire occurred in one of the cylinders. With the bi-metallic piston no rupture of the oil film between the skirt and cylinder liner wall occurred and within a few minutes the fire burned itself out. No shut-down was necessary. In the past, a similar occurrence forced a shut-down of the engine and did considerable damage to piston and cylinder liner.

An incidental, but important, feature of the aluminum coated piston is its ability to lessen the hazard of crankcase explosion. Since there would be no incandescence in case of a piston seizure, one of the more likely causes of crankcase explosion is eliminated.

The seven engines in the Freeport generating plant have a capacity of 11,650 kw. Peak load is 8500 kw. Engines No. 9 (the first equipped with the new pistons) and No. 10 do most of the work. Engine No. 10 is a 3850-hp. Nordberg. The plant serves between 8000 and 10,000 homes and several hundred small industrial plants. It is linked to the grid of the Long Island Lighting Company, but Mr. Moore is proud of the plant's service record, for it has never been necessary to draw on the power company for service.

Freeport has had a municipally owned power plant since 1894. Original equipment consisted of reciprocating steam engines. These were used until 1921 when the first diesel, a 365-hp. unit was installed. This engine has since been retired and, as the demand increased, six larger 2-cycle engines were purchased. Continuing increases in power demand led to the purchase of the big Nordberg (No. 10 engine) in 1949.

Aluminum clad piston after service. Scratches indicate where hard particles worked down the skirt with no serious damage to the piston and none to the liner.

The power plant has earned a reputation for efficiency and progressiveness. With respect to efficiency it is interesting to note that the plant pays the city $60,000 a year in lieu taxes, provides free street lighting at a production cost of $70,000 per year, and yet gives the Freeporters some of the lowest electric rates on Long Island.

Coupled with the economic aspects, some innovations are attracting attention on a national as well as on an international scale, some foreign city governments having sent delegations to study the plant's operation. In addition to the project described, Mr. Moore is credited with being the first to operate large diesels on "Vapor Phase" cooling. Plant records show that since starting operation with the jacket cooling water at 232° F (two of the older engines have been so converted) there have been definite operational improvements as well as an increase in the kw. hr. produced per gal. of fuel oil. This, however, is another story.

Failures of two cast iron pistons due to overheating. Piston on the left is scuffed while the one on the right has a heat crack fro mthe intense heat.

DIESEL BRIEFS

Irrigation and Power Project Progresses

Initial progress on the $77,000,000 Falcon Dam and Power Plant, near Laredo, Texas, is rapidly gaining headway as equipment and materials are brought to the site, one of the largest single projects attempted in the lower Rio Grande Valley.

This Rio Grande International Storage Dams Project will aid the development of rich truck garden and citrus growing areas through controlled irrigation along with hydroelectric development and flood control. The project is interesting in operation due to the fact that it is a joint undertaking by the United States and Mexico pursuant to the Water Treaty of February 3, 1944.

When completed in 1953, Falcon Dam will be of rolled earth construction, having a total axial length of 26,294 feet. Of this length, 10,133 feet will be in the United States and 16,161 feet in Mexico. The crest of the dam will be 35 ft. wide and the maximum height, above present river bottom, will be about 150 ft. Seasonal high river levels are expected to fill the 4,000,000 acre-foot-capacity reservoir. Water supplied for irrigation purposes will be divided in proportion to the investment of each government.

Construction on the initial 18,000,000 cubic yards got underway January 2, 1951, though the building of access roads, loading dock, and land clearing commenced in December, 1950. At present, operations are about half-strength, but as soon as the equipment draft is completed, production will be about 60,000 cubic yards a day. Time allotted is 700 days.

Natural Gas Pipeline Expansion

According to the fourth annual pipeline survey of the Gas Appliance Manufacturers Association, current construction of 7618 miles of new natural-gas pipeline involving expenditures of $630,000,000 will service 125 cities of 50,000 or more and countless neighboring communities. This latest expansion, authorized in 1950 by the Federal Power Commission, now brings the pipeline aggregate to a total of 296,000 miles.

Current proven recoverable reserves, as estimated jointly by the American Gas Association and the American Petroleum Institute, are at 185.6 trillion cu. ft.—5.2 trillion over reserves of the preceding year — despite record consumption of natural gas during 1950.

Subcontractor Clinics

Businessmen had further opportunity to learn the needs of the Armed Forces at sub-contractor clinics held recently in San Francisco, Seattle, Fort Worth, Minneapolis, St. Paul, and St. Louis.

A clinic will be held in Cleveland the week of July 23 to 30, and clinics will be held in Detroit, Los Angeles, Atlanta, and Pittsburgh.

New Research Laboratory

Construction has begun on a new $600,000 research laboratory at Illinois Institute of Technology. The building will be used for the expanded scientific and technological research program at Armour Research Foundation of the Institute.

There will be research facilities for about 200 scientists and engineers, and the building will house activities in mechanisms and propulsion, structures, heat and power studies, and metallurgy.

Cummins Expansion Plan

A major expansion of engine production capacity, involving new facilities to cost $6,000,000, is being planned by the Cummins Engine Company, Inc. It is to be completed in only two years and is to equal expansions made in the past five years. This third major expansion program within the past nine months will increase production capacity at least 50 per cent over the 1950 level.

The new expenditure of $6,000,000 is earmarked for increased production of various engines and replacement parts; installation of semi-automatic machine tool lines; erection of a new building of approximately 20,000 cu. ft.; additions to the research laboratory, a dealer repair shop, classrooms and other additions for training sales and service men; and continuation of the program to replace equipment and utilize latest developments.

DIESEL BRIEFS

Record Diesel Locomotive Order

A large eastern railroad has, according to the Association of American Railroads, placed orders for a total of 387 diesel-electric locomotive units, to cost approximately $64 million. This is probably the largest single diesel purchase ever made by an individual railroad.

The order included 270 freight units, ranging up to 1600-hp., 30 passenger units of 2250- and 2400-hp., and 87 road-switching and yard-switching units. The order, divided among four groups of manufacturers, aggregates 600,000-hp.

Engineering Education Conference

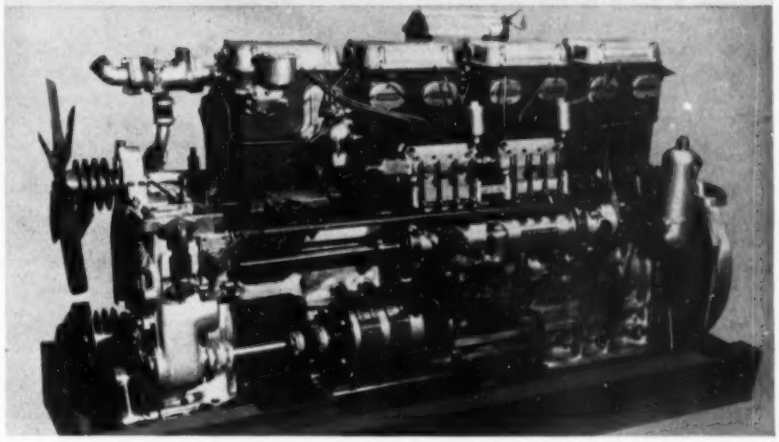
Engineering drawing and thermodynamics schools highlighted the annual conference of the American Society of Engineering Education at Michigan State College, held from June 21 to July 7.

An engineering drawing school featured student drawing exhibits, teaching aids and industrial displays. There was a ten-day thermodynamics school and a two-day school in civil engineering. A humanistic-social conference discussed the curricula for engineers outside their specific field.

Rock Island Diesels

The Rock Island Lines recently received three new diesel freight engines, the first of 84 ordered for delivery by early next year. Costing $486,000 each, they were manufactured by the Electro-Motive division of General Motors Corp. The engines, made up three separate diesel units each, develop 4500 hp. and are capable of pulling a 100-car freight train at 65 miles an hour.

The new equipment will help to bring about 100 per cent dieselization of the railroad's motive power by the end of 1952. Included will be passenger and freight engines, switches and suburban engines.



New Diesel Truck Tractor

An interesting tractor-truck unit built by the Corbitt Company for Turner Transfer, Inc., of Greensboro, N. C., and Reading, Pa., is now hauling loads over the highways of the East. The unit is an unusually high cab-over-engine powered by a Gardner diesel made in England and imported exclusively by Turner Transfer, Inc. The first unit incorporates a special Turner design of trailing axle. Nine additional units now being manufactured will be standard 4 by 2 tractor trucks.

The Gardner engine, a straight 8, has an aluminum crankcase and weighs only 1850 lb. The fuel consumption is 360 lb./bhp./hr., under full load at standard conditions Change of sump oil when using a detergent is necessary after 4000 miles, if the fuel has a sulphur content up to 0.8 per cent, but 6000 miles may be run if fuel has sulphur content of less than 0.3 per cent. Frequently 140,000-200,000 miles are regularly run with Gardner engines before major overhaul is required.

The engine under complete control of the governor from idling speed through to full speed, is controlled by an air operated accelerator. The clutch mechanism is also air operated. This enables the engine to be completely flexible, and mounted on the Gardner patented flexible mounting.

Diesel Repair Shop

A new diesel locomotive repair shop is planned by the Milwaukee Road on the grounds where steam locomotives are being repaired. This will separate the diesel repair and service work now being done in the service shop. The new structure is to be 90 by 200 ft., one section to be sufficiently high to permit the operation of an overhead crane. Completion is promised sometime in November.

Some Considerations Involved in
Selection and Casting of Babbitts
for Engine and other Bearings

*by Robert V. Simpson**

Once again, tin is not only costly, but a critical material. NPA order M-8 places pig tin and tin-bearing alloys on allocation and restricts import and export, purchase, and end-use of these materials. Recognition is given to the power and transportation industry requirements, but in many cases only a percentage of base period usage is allowed.

Fortunately, during World War II, the Batelle Memorial Institute developed an excellent bearing material, No. 397 silver babbitt, that can be used in place of the tin base "high speed" babbitts without sacrifice of service life or efficiency and with no cost penalty to the bearing user. Several firms were licensed to produce and market this material, consisting essentially of approximately 3 per cent silver with a base of lead and antimony.

Following is a discussion of babbitt metals including No. 397 nickel babbitt. Their characteristics, effects of various components on the alloys and procedures for shell preparation, as well as casting are given in order that maximum benefits can be obtained from the material used.

A BEARING is that part of a machine which bears on a second member, but at all times permits a freedom of motion. The motion may be rotating, oscillating or sliding. The load or pressure supported may vary from a light constant weight to a heavy load or an intermittent shock load; the load may be applied from one constant direction or may exert pressure rotating in a vector through 360°. The speed of motion of the journal may vary to extremes. The type of lubricant, the temperature about the application, dirt or abrasive conditions present are just a few of the considerations in speaking of bearings.

Bearing Criteria

The whole problem is complex, so we must think of the bearing in its simplest form and apply basic rules. Bearing characteristics required, listed in order of preference of importance would be:

1. Anti-frictional properties — seizure resistance.
2. Conformability
3. Embeddability
4. Fatigue strength
5. Corrosion resistance
6. Bondability

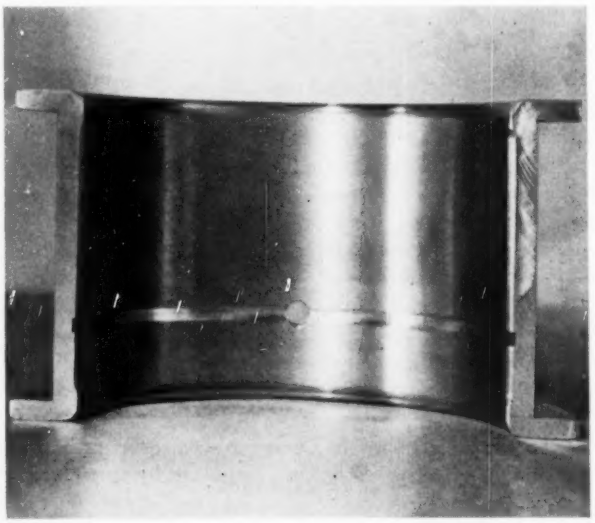
Seizure resistance is considered not only for what its name implies, but also because of the material's inherent anti-frictional properties. During marginal or failing lubrication, when metal to metal contact must be sustained, it is the bearing's anti-frictional characteristics which must permit continued motion until lubrication film can be reestablished.

Babbitt metal, both tin and lead base, is considered best on the basis of seizure resistance and anti-friction properties.

The second characteristic required of a bearing is conformability. This is the property of plasticity, the ability to be changed in shape or molded to a required contour. It permits a bearing to be "broken in" or "worn in", providing a bearing bore concentric to the shaft, and permitting the proper distribution of the load, thereby reducing unit bearing pressure.

Conformability is equally important as the problem of shaft deflection. When torque is applied, the shaft has a tendency to become minutely bowed or deflected from the normal. The bearing is subject to pressures foreign to ordinary power driven loads and must possess the ability to distort or conform to the new condition. Babbitt metal's comparatively low elastic modulus makes it ideally suited to fill the requirements of conformability.

Embeddability is another mechanical requirement of a bearing and is closely associated with conformability. It is



Typical bearing with silver babbitt lining material.

**National Bearing Division, American Brake Shoe Company, St. Louis, Missouri.*

the ability of the bearing material to trap and bury foreign particles; the plastic nature of the medium lets it wipe over the hole so that the harmful abrasive is swallowed beforge damage is caused. Babbitt metal possesses superior qualities in this respect.

Fatigue strength is an abstract quality, almost impossible to measure, but none the less a characteristic to be considered when selecting a bearing metal. This is especially true when bearings of two or more metals, such as steel-back bearings with copper-lead lining or bronze back and babbitt lining are desired. Bearing failures where the lining has "shelled-out" or spalled out were once almost universally classified as instances of improper bonding or complete lack of bond. However, when the nature of fatigue failure became more clearly understood, the importance of fatigue strength was established and several new concepts of bearing backs and linings were advanced.

It is believed that fatigue failure is caused by heat generated at the point of metal to metal contact, causing a temperature rise in the lining which in turn is transmitted to the back. This results in an expansion of both the metals, but due to differences in the amount of expansion, excessive stresses are set up. To elaborate on this would involve consideration of the thermal co-efficients of expansion of the materials. It should suffice in this discussion to point out that repeated local heating accompanied by the extra-ordinary tensile stresses, combined with normal compressive stresses, cause flexing and in turn cause cracks. Continued operation results in spalling from high oil pressure developed in the cracks.

The condition cannot be eliminated as a possible cause of failure, but it can be lessened by the use of a backing material with a thermal expansion figure of 22 to 24, whereas the bronze has a figure of 18 and steel, 12. Thus the stresses caused by heating in steel back bearings exceed those of bronze back babbitt lined bearings by the ratios of the differences, or approximately 2 to 1.

The point here is simply that babbitt lined bearings with steel backs have a greater chance of failing due to fatigue or shell-out than do those of bronze backs, all else being equal.

Bonding ability is another desired characteristic. Mechanical methods of bonding (dovetailing, doweling, etc.) have been used for many years, but have been almost entirely replaced by chemical bonding in modern practice.

Bearing Selection

Where design considerations indicate babbitt as a suitable bearing material, the first step is to decide the type to be used. This depends on the end use of the bearing and the conditions under which it must be applied. Tin base alloys are used primarily in high speed service, for high bearing pressures, and where impact is involved. The lead base babbitts have better embeddability and conformability characteristics, have superior antifrictional qualities and are less expensive, but are inferior to tin babbitts in ability to withstand impact; they are not as easily bonded as the tin base metal, which is itself an excellent solder or tinning agent.

Various elements in babbitt have different functions and appear in different quantities in a range of brands. In general, the elements have the following properties as components of babbitt metal:

TIN-toughens the alloy, lowers the melting point and resists corrosion, but is somewhat lacking in anti-frictional qualities. Under heavy friction tin tends to heat quickly and to fuse.

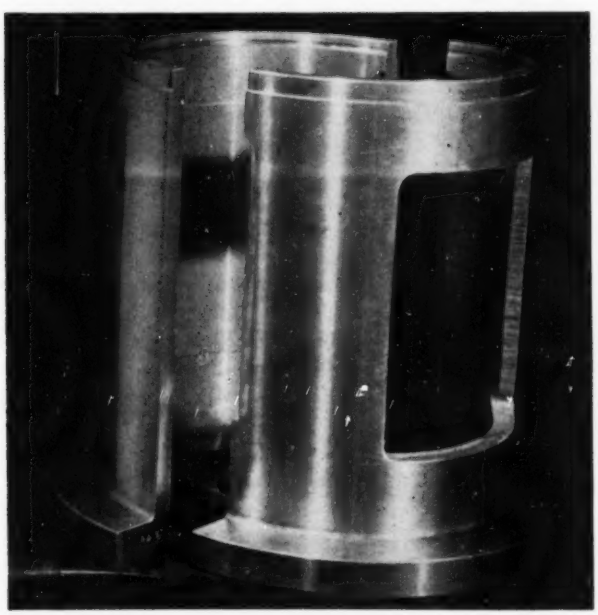
LEAD-softens the alloy and is more anti-frictional than any other metal. This property seems to lie in its ability to absorb oiliness and in its inherent resistance to seizure.

COPPER-hardens and toughens the alloy when the alloy contains tin. It raises the melting point and increases friction slightly. These properties are due to the formation of tin-copper needles. Alloys containing less than 10 per cent tin should contain very little copper, preferably not more than 0.5 per cent, but with close control, 1 per cent may be tolerated in some cases.

ANTIMONY-hardens the alloy at the expense of ductility, raises the melting point, reduces friction and is resistant to corrosion. It is imperative that antimony segregation be prevented.

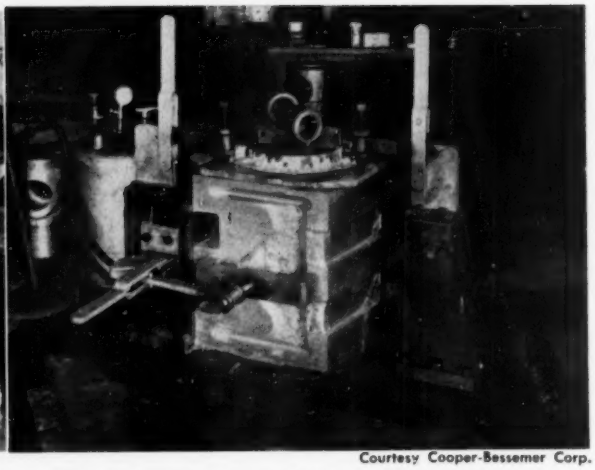
SILVER-added to lead base alloys markedly improves its retention of hardness at elevated temperatures, and also changes lead from a poor bonding material to a solder of recognized value.

The ideal babbitt would be as hard at 300° F as at room temperature, but unfortunately none exists, so we must compromise. The babbitt having the greatest remaining strength at running temperatures will give the best service. A way to determine this is by plotting figures of hardness against tempera-



Finished motor support bearing for a diesel locomotive.

Improper way to make a bearing. No provisions are made to hold bearing in place or for a riser.



Courtesy Cooper-Bessemer Corp.

Properly made casting jig. Mandrel is accurately located and jig can accommodate the backing. No babbitt can leak.

ture; the babbitt giving the closest approach to a straight line will give the best service at operating temperature.

Melting and Tinning Procedures

Babbitt melts at a relatively low temperature, for example:

Type	*Formula*	*Melting Range*
Tin Base	89-10-5	460 to 691°
Lead Base	75-15-10	464 to 514°
No. 397	.....	470 to 496°

An iron or cast steel pot is ideal and most any fuel is suitable; however, the flame should not be allowed to contact the metal. The metal should be stirred regularly as babbitt will segregate into undesirable compounds.

Temperature is of utmost importance and precautions must be taken to keep from over-heating the babbitt, as excessive oxidation and drossing will occur. If the dross is carried over into the cast lining, excessive porosity will result when machined.

A controlled superheat is generally required to compensate for cooling between the pot and the bearing. Runners, spouts, etc., should be heated to minimize this loss. Normal pouring temperature for No. 397 nickel babbitt is 630°-680° F, which provides 130°-160° F superheat.

Pyrometric equipment is a good investment in any shop where babbitt metal is poured. However, an inexpensive substitute, "Tempil" marking crayons, give a fairly close approximation of temperature by their graded melting points. If the molten babbitt does become over-heated, it is necessary to cool and clean the surface with sal-ammoniac and skim off the dross before proceeding.

Two different babbitts should not be mixed. Do not make the mistake of believing that, for example, tin-rich borings will "build-up" a lead base material. To the contrary; the alloy was designed as a balanced compound to take advantage of each element's beneficial properties. By mixing dissimilar alloys, the advantages of each are lost.

Surface preparation should receive primary attention. The success or failure of the bearing depends to a large degree on proper bonding. This is a chemical bond and we attempt to produce a condition in which there is a mingling of a layer of metal between the bearing metal and the shell.

One must obtain a chemically clean surface for effective tinning. This can be done most successfully by taking a fine cut on the inner shell surface in a lathe, and by tinning while the surface is fresh. A smooth surface is desirable; avoid the so-called "phonograph finish" which, by causing variations in lining thickness, will give possible points of failure.

Where machining is impossible or impractical, we must resort to strong alkalies or acids to produce a chemically clean surface. Bronze bearing shells are the easiest to prepare. First, the surface should be thoroughly degreased, using a solvent, and then fluxed with the chemically active eutectic mixture of zinc chloride and ammonium chloride, that is to say, a mixture of 71 per cent $ZnCl_2$, 29 per cent NH_4Cl, or roughly 8 lbs. ammonium chloride and 19½ lbs. zinc chloride to 15¾ qt. water. The shells are then ready to be tinned at 650° to 700° F.

Many bearings are backed by cast iron or a mild steel, and present a more difficult bonding problem. We seek to obtain a surface of pure iron or ferrite. Therefore, carbon and oxides must be removed.

The ideal preparation is by anodically etching, or electro-etching. The equipment involved, however, is usually found only in a shop which does this work commercially. Lacking such equipment, first, all the greases and oil must be removed by degreasing solvents or a caustic material. Then the shells should be boiled in a strong caustic solution of soda ash and sodium phosphate for from 10 to 15 minutes, followed by a water rinse.

If it is impossible to take a light cut off the shell, it must be pickled to produce a reactive surface. Five minutes in 10 per cent hydrochloric acid solution should produce a surface of pure iron or ferrite for reaction. The shell should then be fluxed with zinc chloride (3 oz.-$ZnCl_2$, 7 oz.-H_2O) and is ready for tinning.

Surfaces not to be tinned can be protected when in the solder bath by using a coating of ordinary white

wash. Another good masking solution often used is:

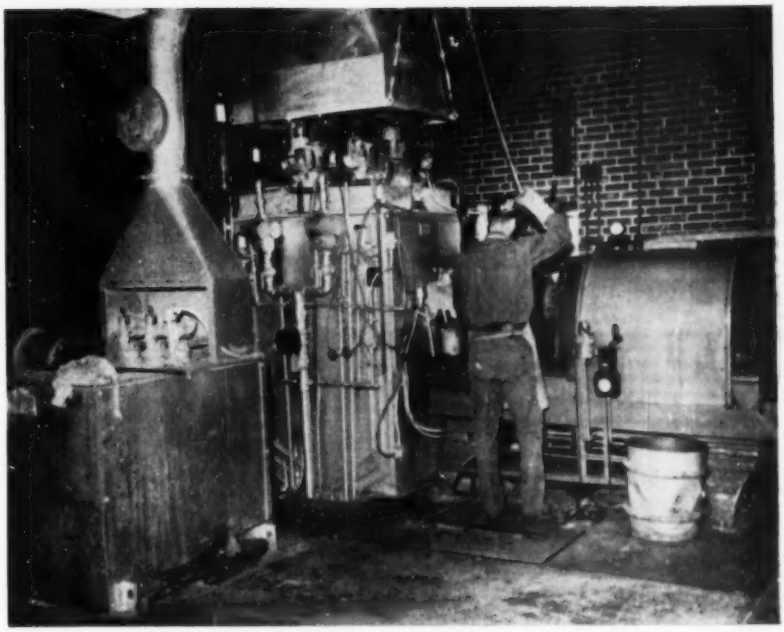
1 lb. Magnesium Oxide (MgO)
2 pt. Sodium Silicate (Water Glass)
1 pt. Water

The solution is brushed on and allowed to dry; a second coat may be necessary. When desired, it can be removed by hot water and brushing.

Tinning solders are available in a wide range of tin-lead variation. The fundamentals to consider are the solder's melting range, its ability to "wet" and alloy with the base metal, and its having reasonable strength and freedom from brittleness.

A 65-35 tin-lead solder is the easiest to use when the bearing shell can be immersed in the solder bath. This is because the liquidus-solidus spread of the solder is practically zero and the metal is very fluid. Immersion serves two purposes; one, to coat the surfaces, and two, to raise the bearing temperature.

Where the bearing shell is too large for the solder pot, 40-60 stick solder is preferable because of its spread in melting range, giving the operator more time to pour the bearing as the tin-coating stays molten longer. The heat source is applied to the back of the shell, avoiding hot spots, until brought to about 370° to 450° F. A torch or flame should never be applied to the prepared surface. Take time for this operation and use plently of flux and sal ammoniac to obtain desirable results.



Bronze diesel engine main and connecting rod bearings, also bronze motor, axle and armature bearings, are babbitted centrifugally on electrically controlled equipment.

Casting

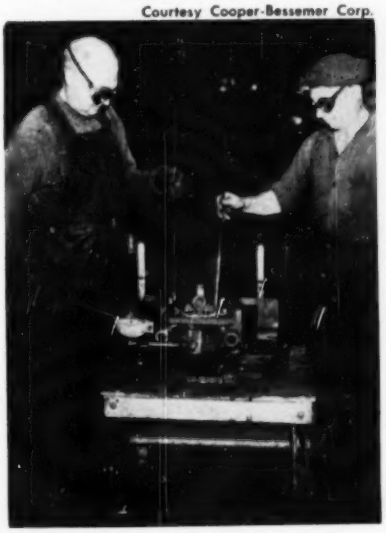
Pouring the babbitt bearing is not complicated, but there are a few points to be considered. Best results are usually obtained when the same man pours a particular alloy, as there is a difference of behavior of tin base and lead base babbitt.

The metal must be poured while the tin on the prepared surface is still molten, or an effective bond cannot be obtained. Melt the babbitt as near as possible to the pouring station to avoid cooling in transit. Be sure to have sufficient babbitt melted, as the bearing must be poured in one continuous operation to avoid cold shuts or layers and seams.

One way to achieve this when pouring a large bearing is to have two men with ladles—one pouring while the other is refilling his ladle. Once you have started to pour, continue in a steady stream, but not so fast that air is trapped in the cavity. It is good practice to puddle the molten babbitt to release any air or gas bubbles or voids when pouring a quantity of the alloy. A steel rod of suitable section is ideal for this.

The babbitt will shrink as it cools, and preparation must be made to allow for a riser or a reservoir of extra babbitt to feed into the lining. Continue to pour hot metal into the riser as it settles.

Puddling procedure for static casting.
Courtesy Cooper-Bessemer Corp.



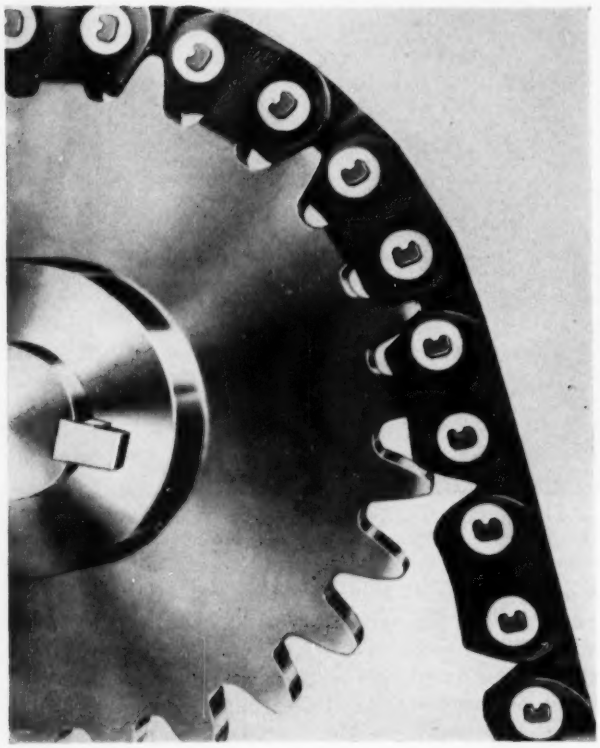
The optimum results are obtained when the babbitt metal chills from the backing inward, that is to say, toward the center of the bearing bore. This is achieved by applying an air blast, a water spray or wet rags to the back of the shell.

Centrifugal Casting

An improved method is commonly used by larger bearing manufacturers, involving centrifugally casting the babbitt into the shell. The bearing is mounted on a machine such as a lathe bed and is held by end plates which also act as retainers. One plate has a hole through which a carefully metered quantity of babbitt is introduced into the rotating bearing.

Immediately after the babbitt enters, a water spray is played on the shell. The entire operation is electronically controlled; the operator simply takes a bearing from the tin pot, places it in position and pushes the activating button. When the cycle of operation is completed, he lifts the babbitted bearing out of the machine and onto a conveyor. The speed at which the bearing revolves is carefully calculated to avoid segregation.

Morse High Velocity Chain Drive



Left—Sprocket teeth of the Hy-Vo drive are involute in contour. The chain and sprocket engagement principle virtually eliminates chordal action, and reduces shock loading and stresses in the links.

A new transmission chain, which should have considerable application in the diesel field has been recently developed by the Morse Chain Company. This chain known as the Hy-Vo (high velocity) provides a power transmitting medium that, while retaining the many advantages of other types, provides the features of greater smoothness and lack of vibration.

The high performance of the new transmission chain (efficiencies of 99.5 per cent have been reported) is dependent upon a combination of several factors. Most important of these is the fact that chordal action and its destructive effects are nearly eliminated. This is brought about in the new design so that during the period of load transfer between chain and sprocket, there is no appreciable change in the pitch radius. This results in a more constant speed relationship between chain and sprocket, so that a reduction of shock loading and the highly aggravated stresses in the chain links, as well as noise, vibration, and heating are greatly reduced.

Redesign of the sprocket has also aided materially to the efficiency of the new drive. Sprocket teeth have been adapted to the involute tooth principle, so that the links are engaged with conjugate action.

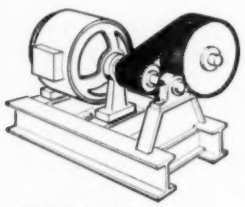
Another feature is the new type compensating rocker joint, which allows the pitch line to automatically shift during link articulation, so that the links engage the involute sprocket teeth and permit the chain to follow a path truly tangent to the pitch circle. This compensating rocker joint acting in conjunction with the sprocket teeth makes possible the involute or rolling action. The rocker joint has been further refined for the reduction of slippage and wear in the joints.

Other important features are a balanced chain link design with improved stress distribution, new alloy material for the link and pin, and the use of several new metallurgical processes that improve resistance to fatigue.

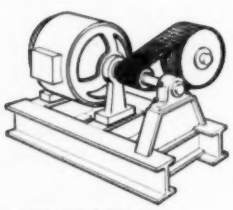
In addition to being able to operate at much higher speeds than the conventional roller and silent chain drives, much narrower chain widths can be used as well. Furthermore, with the new chain drive, unwieldy units with costly shaft extensions, outboard bearings, mounts and other accessories presently required have been eliminated.

Pitch elongation or "stretch" has been reduced to the point where it is virtually unnecessary to provide any means of take-up. This feature gives the new drive many uses in engine compounding, timing chains, and heavy-duty power transfers where cen-

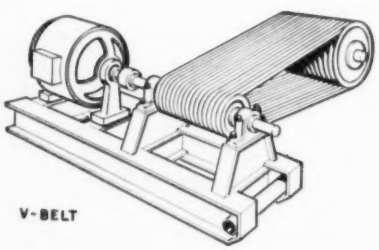
Right — Comparison of the different drives transmitting the same horsepower. Note the Hy-Vo economy in space requirements.



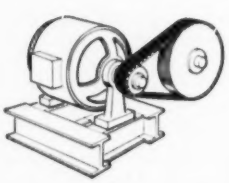
SILENT CHAIN



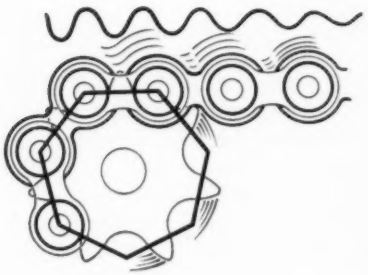
ROLLER CHAIN



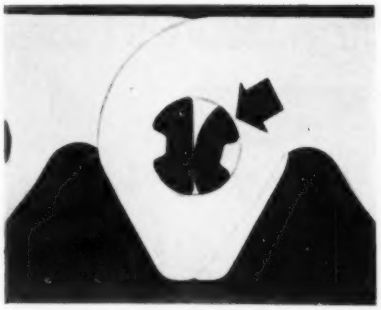
V-BELT



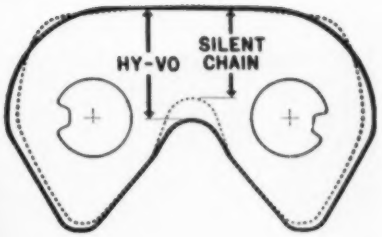
HY-VO



Conventional chain during engagement is subject to chordal action.



Hy-Vo compensating rocker joint automatically shifts pitch line.



Link has greater strength due to having more metal in line of pull.

ter adjustment has proven impractical.

Company engineers report that Hy-Vo drive gives industrial users, and engine and motor designers, a power transmission drive that will allow them to develop and use much smaller and more inexpensive power plants. Such plants previously had been ruled out because compact, low-cost, power transmission equipment was not available to handle the speeds required to produce high horsepower in small engines. Single drive units capable of transmitting as much as 5000 hp. at linear speeds up to 5400 fpm., or rotative speeds up to 3600 rpm. are possible.

During installation the same precautions must be taken as for any power chain drive.

Sprockets should be installed on shafts which are well supported by suitable and rigidly mounted bearings, and located as close as possible to the bearings. The shafts must be parallel. Sprockets must be aligned to within 1/32 in.

Chains should be installed fairly tight with only a small amount of slack. Vertical drives should receive special engineering attention.

The chain should be protected against dirt and dust by means of dust proof drive cases and in the case of outside drives, rain shields should be provided.

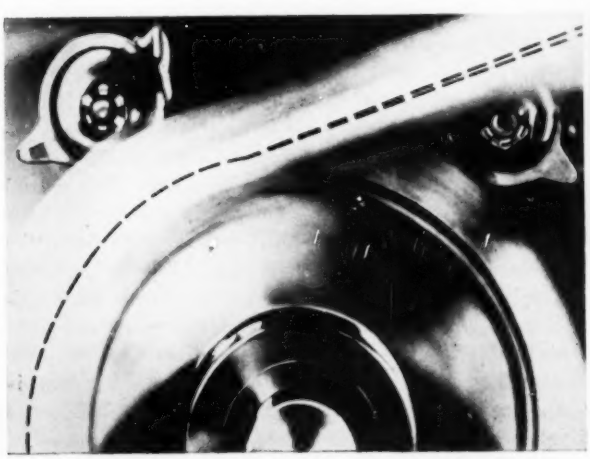
As for lubrication of the chain, disc or slinger methods are satisfactory at speeds up to 3000 fpm. Speeds over 3000 fpm. require pump lubrication, with an orifice spraying oil on the inside surface of the lower strand. Lubricant feed should be equivalent to two quarts per minute for each inch of chain width. Separate oil supply is recommended on engine installations. Oil coolers are not required as these drives run very cool.

At present Hy-Vo drives are being produced in 1-, 1½-, and 2-in. pitches, in the most demanded widths. The range of pitches is being expanded as rapidly as possible. For chains having uneven numbers of pitches, offset or "hunting" links are available, but should be avoided and used only in cases of emergency. It is impossible to design an offset link having the strength of a straight link; consequently a sacrifice of endurance is inevitable if offset links are included in the chain.

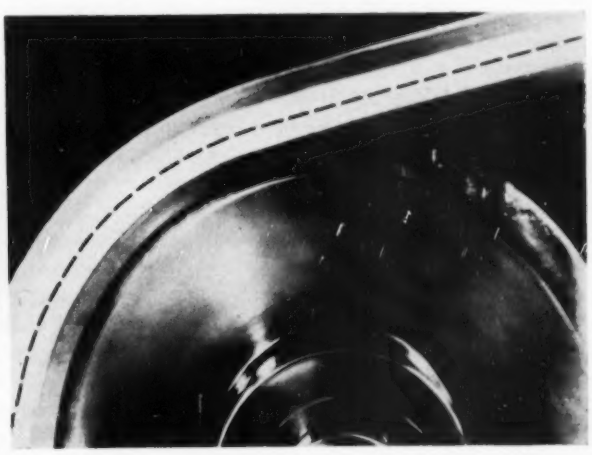
Due to the present shortage of materials, it is necessary to restrict orders for the new drive to those with defense or essential ratings.

Morse Company engineers emphasize that Hy-Vo drives in no sense replace present roller or silent chain drives, but supplement them. They are designed specifically for speed applications higher than conventional chain drives, and to replace unwieldy belt drives now required for high speed power transmission.

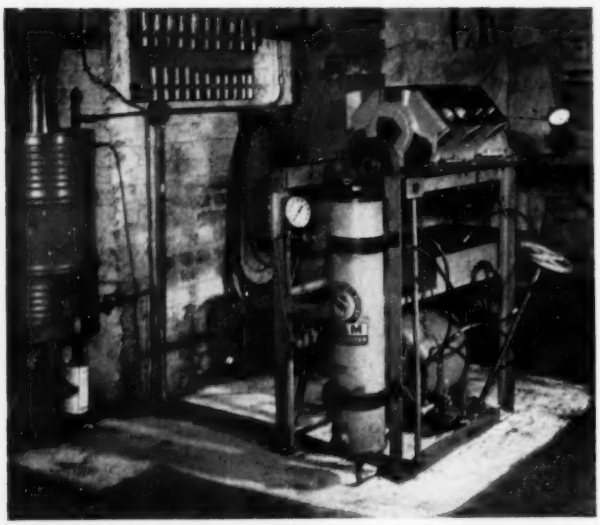
Conventional roller chain drive operating at 3600 fpm. Note bumping or chordal action.



Hy-Vo drive operating at the same speed as chain at left. Action is smooth and quiet.



Engine Run-In Stand



Engine run-in and test stand for running in and testing of engines before placing them in service.

THERE is a great deal in favor of giving an engine a preliminary run-in period prior to operation under its own power. Motorizing an engine before subjecting it to the forces of combustion is time well spent, for even with the accuracies obtainable in present day engine rebuilding practices, many small metal particles are removed while mating parts become adjusted. The A. L. Torgis and Son, engine rebuilders, of Toronto, realizing this, have built an engine run-in and test stand for their shop. A description of their stand and running-in procedure should be of interest.

The stand is made of welded angle iron, with mountings for the engine to be tested on the top rails. Under the engine is the oil sub-pan, in which the oil collects, and on the bottom is the driving motor with high and low speed pumps. The 5-hp. driving motor is mounted on a steel plate, and to one side of this plate is welded a piece of steel rod, which gives an arrangement that allows the motor to slide from one end of the machine to the other. Easy alignment of the drive belts with various engines is thus assured. On the other side of the motor mounting plate is attached a take-up arrangement for the drive belts.

A slow speed motor is desirable. An engine speed of 350-400 rpm. is used for testing the oil pressure at idling speeds. For running-in of the engine a speed of 400-800 rpm. should be used. Speeds higher than this would require a coolant in the block. Belt drives to two oil pumps are taken from the motor. The slow speed pump, which delivers oil to the engine, should operate at 500-rpm., and the pump that transfers oil from the sump tray through the filter to the storage drum should run at 1000 rpm. On the pressure side of the former pump, an adjustable relief valve is set to by-pass excessive oil that is normally taken care of by the relief valve on the engine.

The location of the drive belts to various lengths of engines is made by sliding the motor drive along the hinged rod. The drive couplings have been standardized, and approximately one dozen drives take care of all popular engines, including International, Waukesha, GM, and other truck engines. Whenever possible the couplings are bored to fit over the end of the crankshaft. A set screw and plug are used to hold the drive on the shaft.

A 26 gal. oil storage drum of SAE 10 with 25 per cent additive, which prevents rusting when engines stay in stock, is used as the oil supply. Connection to the storage drum is made to the inlet side of the slow speed pump and is carried in a line through the adjustable relief valve, a shut-off cock, pressure gage (0-100 lb.) and a flexible line which makes connection to the oil gallery of the engine. The relief valve by-passes oil to the storage drum. Between the relief valve and the gage the shut-off cock is placed so that the same pressure gage can be used when testing with oil in the crankcase, at which time the relief valve on the engine is in operation. A flexible hose is connected from the sump tray to the suction side of the high speed pump. From the pressure side of this pump the oil is pumped to the oil filter. (Fram 244P2), and then to the storage drum.

After the engine is assembled in the test stand the motor is run for a minute to pump oil to the bearings. The pulley is then assembled, the drive belts adjusted, and the engine run at 500-800 rpm. for a break-in period of one to two hours.

A slow speed pulley is then attached and the oil pressure checked under idling conditions. The oil supply from the storage tank is then cut off and the required amount of oil added to the crankcase. The engine is again started and this time the oil is circulated by the engine's oil pump. Oil pressure should be the same as that produced by the slow speed motor operated pump.

The tappets are readjusted, cylinder head retorqued, compression tested, and timing cover and oil pan inspected for leaks. Engine is now ready for shipment.

If low oil pressure is experienced, the pan should be dropped and with the drive belts off, pressure pumped to the bearings to determine the cause of the leaks. Many times it is only necessary to re-adjust the pressure relief valve or use a stiffer spring. Another source of leaks has been around the front oil seals in engines that have the front oil seal in or partly in the timing gear cover. This is due to the clearance in the bolt holes being sufficient to cause enough misalignment to create undue wear in the seal. To remedy this condition, a sleeve is placed over the shaft to locate the cover before tightening the bolts.

The Role of Management in Getting

Maximum Economy of Diesel Locomotives

A comparison of the economies in the operation of steam and diesel-electric locomotives shows startling results in favor of the latter. On this basis, the railroads are well satisfied with their diesel purchases. Is this the ultimate or is there room for improvement? In a recent talk, Mr. N. C. Dezendorf, Director of Sales and Service, Electro-Motive Division of the General Motors Corporation, reflecting the views of his organization, indicated that such was not the case. One phase of his ideas on obtaining maximum economies in the operation of diesel-electric locomotives is presented at this time.

Incentive for the rapid dieselization of our railroads is the economic advantages which this form of motive power offers in comparison with the steam engine which it displaces. The economies affected can be broken down into four general headings: Basic; Operating; Development; and Management.

The first two, basic and operating economies, are inherent in the design characteristics of the diesel locomotive and result to a large extent even if diesel locomotives were substituted for steam locomotives, with little other change in equipment, organization or methods.

Development economies, the next of the headings, is largely a function of the manufacturer and is a field in which great strides have been made. Since the first standardized unit to leave the LaGrange plant in 1936, just 15 years ago, 10,000 units have been produced. A tremendous amount of research and development took place during this period.

A few development highlights include a 33 1/3 per cent increase in horsepower per cylinder; greater fuel economy with an ability to burn a wider range of fuels; piston life increased from 75 to 100 thousand miles to between 600,000 to one million miles. In general, metallurgy and design have combined to give all engine parts longer service life.

Similar increases in the life of electrical equipment can be cited. Traction motor ratings have been increased over 25 per cent while the periods between overhaul and re-winding have been increased from 200,000 to 300,000 miles and from 400,000 to 1,000,000 miles or more, respectively. These figures are for high speed passenger service.

All these are direct factors affecting economy of operation. To them must be added the many indirect or collateral savings. There remains the subject of management economies that will now be discussed in greater detail.

The diesel locomotive is still a new tool for the movement of trains on our railroads. Much still remains to be learned concerning the methods of using this new tool to the utmost advantage in building traffic, offsetting competitive forms of transportation, and in effecting maximum economies of operation. The knowledge and experience which are required to fully exploit the potentials of the diesel locomotive lie within the area of management decisions.

To the extent that railroad management exhausts these potentials will they approach the maximum economies attainable. Conversely, to the extent that railroad managements tend to follow steam practices in the application of diesel locomotives will the maximum economies fail to be realized, even though the savings are substantial and the railroad is satisfied with its diesel purchases.

Although railroad accounting is well established and controlled by I. C. C. regulations, and while all of the basic data for the analysis of diesel locomotive performance is available, there exists no separate summary of diesel locomotive operation and expense information for comparing one railroad with another. In developing management techniques for improving operations, a factual guide to deficiencies requiring management decisions is a basic necessity.

Since one did not exist, the Electro-Motive Division decided about 5 years ago to create an "Operating Comparison Report" provided that the cooperation of railroad managements could be obtained in supplying basic data. From a modest beginning, over 30 of the principal railroads of the country are now sending them regular monthly reports covering the significant factors in diesel locomotive operation and expense. For the most part, the data covers all diesel units regardless of make, but because of Electro-Motive's position in the industry, the freight and passenger figures reflect approximately 90 per cent EMD ownership, but with switchers approximately 60 per cent.

A sample "Operating Comparison" is shown covering the 12 months ending December 31, 1950. It will be observed that the railroads are coded. Many railroads exchange code letters with each other, but Electro-Motive respects the railroads' desire for anonymity. There is a separate report for freight, passenger, and yard switching. The first part of the report cover

DIESEL PASSENGER SERVICE—OPERATING COMPARISON

CUMULATIVE ENDING DECEMBER 31, 1950

RAILROAD CODE		A	B	C	D	E	G	H	K	L	M	N	O	P	S	U	V	W	Y	AA	AVERAGE ALL ROADS
OPERATING INDICATORS																					
NO. OF MONTHS DATA COVERS		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	7	12	-
AVERAGE AGE OF LOCO. UNITS (MO'S.)		41	30	51	81	46	28	41	59	73	43	79	65	48	50	12	45	57	7	40	50
AVERAGE MILES PER LOCO. UNIT PER MO.		18988	13756	16801	14699	11944	11206	9047	16557	10816	9737	17398	16940	13473	21326	11876	23667	16769	10315	21371	17647
% HRS. AVAILABLE OF HRS. IN PERIOD		83.0	84.3	-	82.2	-	88.1	84.1	72.6	90.7	80.5	72.4	79.5	95.5	84.9	91.0	81.6	-	93.1	87.9	80.1
% HRS. WORKED OF HRS. IN PERIOD		73.4	39.0	-	53.8	-	51.4	44.7	55.6	33.4	30.8	-	66.3	-	55.6	50.5	63.3	-	51.5	72.1	57.2
AVERAGE TRAIN MILES PER TRAIN HOUR		41.1	46.2	41.4	41.6	33.7	37.4	39.3	57.2	43.3	42.5	47.8	44.3	41.2	55.6	31.1	50.6	47.4	44.1	43.1	45.0
AVER. PASS. TR. CAR MI. PER TRAIN HOUR		452	381	383	513	236	354	310	560	610	238	513	394	376	634	207	634	494	282	558	496
AVER. PASS. TR. CARS PER LOCO. UNIT		3.8	3.5	5.3	5.8	6.1	5.8	3.1	3.2	6.7	2.8	4.8	5.2	6.4	5.9	6.6	3.6	6.2	3.1	6.4	5.2
AVERAGE HORSEPOWER PER UNIT		1500	1500	2005	2018	2000	1587	2000	1654	2000	1500	1855	1727	2000	2021	2000	1559	1984	1500	2000	1853
FUEL CONSUMPTION (IN GALLONS)	PER MGTM	.32	.28	.29	.26	.30	.28	.50	.37	.30	.46	.32	.29	.34	.28	.28	.30	.28	.33	.29	.29
	PER LOCO. UNIT MI.	1.22	.98	1.53	1.53	1.84	1.64	2.19	1.18	1.99	1.31	1.53	1.50	2.16	1.67	1.85	1.08	1.73	1.02	1.87	1.49
LUBE OIL CONSUMPTION (IN GALLONS)	PER MGTM	.003	.004	.002	.004	.003	.002	.006	.006	.003	.003	.004	.003	.003	.002	.003	.004	.006	.003	.003	.003
	PER LOCO. UNIT MI.	.011	.013	.012	.021	.020	.013	.027	.018	.023	.008	.019	.016	.017	.012	.017	.015	.035	.010	.009	.016
SIGNIFICANT OPERATING COSTS PER PASSENGER TRAIN CAR MILE (Cents)																					
REPAIRS		3.10	3.08	2.11	2.91	3.38	2.42	3.96	6.21	2.90	5.22	4.43	3.32	1.76	3.02	1.98	2.24	3.43	4.59	1.65	2.95
FUEL		2.97	2.54	2.66	2.39	2.64	3.01	4.80	3.45	3.01	4.88	3.02	2.36	3.12	2.82	2.53	2.49	3.06	3.16	2.39	2.64
LUBRICANTS		.18	.19	.12	.19	.15	.13	.29	.34	.13	.13	.24	.16	.13	.13	.15	.20	.27	.17	.08	.17
TOTAL		6.25	5.81	4.89	5.49	6.17	5.56	9.05	10.00	6.04	10.23	7.69	5.84	5.01	5.97	4.66	4.93	6.76	7.92	4.12	5.76
ANALYSIS OF REPAIRS PER PASSENGER TRAIN CAR MILE (Cents)																					
REPAIRS — ENGINE:	LABOR	.71	.43	.64	-	-	.53	-	1.26	.46	1.18	.68	.52	-	-	-	.31	-	1.19	-	.53
	MATERIAL	.32	.20	.29	-	-	.11	-	1.83	.31	.40	.68	.70	-	-	-	.30	-	.11	-	.42
	TOTAL	1.03	.63	.93	-	-	.64	-	3.09	.77	1.58	1.36	1.22	-	-	-	.61	-	1.30	-	.95
REPAIRS — ELECTRICAL:	LABOR	.42	.30	.22	-	-	.39	-	.58	.37	.53	.39	.32	-	-	-	.32	-	.90	-	.35
	MATERIAL	.38	.50	.19	-	-	.11	-	1.00	.37	.20	.81	.53	-	-	-	.28	-	.12	-	.39
	TOTAL	.80	.80	.41	-	-	.50	-	1.58	.74	.73	1.20	.85	-	-	-	.60	-	1.02	-	.74
REPAIRS — OTHER:	LABOR	.49	.76	.47	-	-	1.02	-	.94	.81	1.83	.82	.52	-	-	-	.60	-	1.82	-	.67
	MATERIAL	.78	.89	.30	-	-	.26	-	.60	.58	1.08	1.05	.73	-	-	-	.43	-	.45	-	.55
	TOTAL	1.27	1.65	.77	-	-	1.28	-	1.54	1.39	2.91	1.87	1.25	-	-	-	1.03	-	2.27	-	1.22
TOTAL REPAIR LABOR		1.62	1.49	1.33	1.48	1.74	1.94	2.48	2.78	1.64	3.54	1.89	1.36	.91	1.73	1.23	1.23	1.56	3.91	.85	1.58
TOTAL REPAIR MATERIAL		1.48	1.59	.78	1.43	1.64	.48	1.48	3.43	1.26	1.68	2.54	1.96	.85	1.29	.75	1.01	1.87	.68	.80	1.46
TOTAL REPAIRS		3.10	3.08	2.11	2.91	3.38	2.42	3.96	6.21	2.90	5.22	4.43	3.32	1.76	3.02	1.98	2.24	3.43	4.59	1.65	2.95
REPAIRS (CENTS) PER GAL. FUEL CONSUMED		9.78	11.07	7.34	11.01	11.30	8.61	7.98	16.90	9.72	11.25	13.81	11.57	5.23	10.67	7.08	7.43	12.35	13.87	5.65	10.07
SIGNIFICANT OPERATING COSTS PER LOCOMOTIVE UNIT MILE (Cents)																					
REPAIRS		11.92	10.85	11.22	16.81	20.77	14.14	17.49	19.90	19.39	14.68	21.09	17.31	11.27	17.77	13.08	8.00	21.36	14.19	10.58	15.37
FUEL		11.41	8.98	14.18	13.79	16.25	17.52	21.18	11.04	20.14	13.72	14.39	12.30	20.00	16.64	16.71	8.89	19.02	9.77	15.29	13.59
LUBRICANTS		.68	.66	.61	1.09	.93	.74	1.39	1.08	.84	.36	1.15	.83	.85	.78	.97	.70	1.69	.53	.49	.81
TOTAL		24.01	20.49	26.01	31.69	37.95	32.40	39.97	32.02	40.37	28.76	36.63	30.44	32.12	35.19	30.76	17.59	42.07	24.49	26.36	29.87

4-51 Report includes all builders.

Tabulation of the operating costs of nineteen railroads for freight and passenger service are given here. The averages for all roads is, however, based on reports from over thirty roads. The widely varying operating costs of the various railroads indicate that considerable improvement in operation and maintenance procedures is possible before maximum returns of diesel equipment is realized.

DIESEL FREIGHT SERVICE—OPERATING COMPARISON

CUMULATIVE ENDING DECEMBER 31, 1950

RAILROAD CODE		A	B	C	D	E	EE	G	K	L	M	N	O	P	R	U	V	W	Y	Z	AVERAGE ALL ROADS
OPERATING INDICATORS																					
NO. OF MONTHS DATA COVERS		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	-
AVERAGE AGE OF LOCO. UNITS (MO'S.)		61	55	47	43	62	30	27	46	25	40	22	35	22	44	38	56	24	34	26	34
AVERAGE MILES PER LOCO. UNIT PER MO.		10441	7635	12523	8756	7567	7344	8438	8596	9611	6454	8620	9979	8356	8337	12635	9381	7810	5762	10867	9350
% HRS. AVAILABLE OF HRS. IN PERIOD		84.1	87.2	-	90.5	-	-	88.8	86.8	98.2	82.6	93.2	86.3	94.4	-	82.0	89.3	92.5	84.6	81.8	87.9
% HRS. WORKED OF HRS. IN PERIOD		69.8	39.8	-	58.8	-	-	54.5	63.0	41.1	41.1	46.2	71.4	-	63.2	61.5	52.0	-	55.2	76.0	58.0
AVERAGE TRAIN MILES PER TRAIN HOUR		22.7	24.4	28.6	23.2	23.4	19.6	17.8	22.1	21.4	17.0	22.8	24.0	21.4	22.6	28.8	25.6	19.0	17.9	26.0	23.4
AVERAGE TRAILING MGTM PER TRAIN HOUR		103.4	82.2	105.4	66.9	60.8	51.2	35.1	63.5	49.0	39.4	-	74.2	55.2	65.2	105.6	78.7	67.8	71.0	88.1	76.1
AVERAGE GROSS TONS PER LOCO. UNIT		1220	854	893	1091	1047	1379	1543	730	938	975	-	1122	1364	1160	1116	862	1491	1596	1275	1038
AVERAGE HORSEPOWER PER UNIT		1400	1467	1439	1412	1364	1500	1500	1439	1500	1499	1469	1440	1500	1436	1404	1404	1491	1437	1500	1460
FUEL CONSUMPTION (IN GALLONS)	PER MGTM	1.52	1.95	1.53	1.75	1.78	1.56	1.68	2.63	1.79	2.10	-	1.74	1.66	1.56	1.49	2.04	1.48	1.51	1.61	1.79
	PER LOCO. UNIT MI.	1.86	1.66	1.37	1.91	1.86	2.15	2.60	1.92	1.68	2.05	2.12	1.96	2.26	1.81	1.66	1.76	2.20	2.41	2.05	1.86
LUBE OIL CONSUMPTION (IN GALLONS)	PER MGTM	.014	.024	.013	.016	.023	.015	.012	.030	.014	.018	-	.018	.018	.021	.014	.029	.013	.015	.015	.018
	PER LOCO. UNIT MI.	.017	.020	.011	.018	.024	.021	.018	.022	.014	.017	.025	.020	.024	.013	.015	.025	.020	.024	.019	.020
SIGNIFICANT OPERATING COSTS PER MGTM (Cents)																					
REPAIRS		11.22	13.10	8.54	13.09	17.70	13.20	10.05	16.40	7.86	19.63	-	10.10	7.76	14.09	8.67	14.94	7.30	17.04	11.93	10.91
FUEL		14.23	17.78	14.03	16.21	15.63	13.81	15.26	24.66	15.45	22.14	-	14.38	14.71	15.80	12.17	16.90	16.25	14.22	16.18	16.06
LUBRICANTS		.91	1.22	.69	.84	1.01	.80	.68	1.75	.68	.76	-	.92	.79	.56	.73	1.31	.63	.75	.81	.98
TOTAL		26.36	32.10	23.26	30.14	34.34	27.81	25.99	42.81	23.89	42.53	-	25.40	23.26	30.45	21.57	33.15	24.18	32.01	28.92	27.95
ANALYSIS OF REPAIRS PER MGTM (Cents)																					
REPAIRS — ENGINE:	LABOR	3.24	2.55	3.16	-	-	-	2.42	4.32	1.53	6.06	-	3.02	-	-	-	2.63	-	4.44	-	2.82
	MATERIAL	2.03	2.37	1.62	-	-	-	.50	3.55	.96	2.63	-	3.49	-	-	-	1.57	-	2.07	-	1.69
	TOTAL	5.27	4.92	4.78	-	-	-	2.92	7.87	2.49	8.69	-	6.51	-	-	-	4.20	-	6.51	-	4.51
REPAIRS — ELECTRICAL:	LABOR	1.68	1.19	.72	-	-	-	1.71	1.97	1.61	2.10	-	.98	-	-	-	2.30	-	3.41	-	1.61
	MATERIAL	.89	3.12	1.04	-	-	-	.44	3.07	.91	.78	-	1.31	-	-	-	.56	-	2.60	-	2.02
	TOTAL	2.57	4.31	1.76	-	-	-	2.15	5.04	2.52	2.88	-	2.29	-	-	-	5.86	-	6.01	-	3.63
REPAIRS — OTHER:	LABOR	1.40	2.39	1.30	-	-	-	4.13	2.28	1.52	5.64	-	.80	-	-	-	2.98	-	3.18	-	2.20
	MATERIAL	1.98	1.48	.70	-	-	-	.85	1.21	1.33	2.42	-	.50	-	-	-	1.90	-	1.34	-	1.17
	TOTAL	3.38	3.87	2.00	-	-	-	4.98	3.43	2.85	8.06	-	1.30	-	-	-	4.88	-	4.52	-	3.37
TOTAL REPAIR LABOR		6.32	6.13	5.18	7.85	9.43	6.10	8.26	8.57	4.66	13.80	-	4.80	4.13	-	4.75	7.91	3.56	11.03	6.65	6.19
TOTAL REPAIR MATERIAL		4.90	6.97	3.36	5.24	8.27	7.10	1.79	7.83	3.20	5.83	-	5.30	3.63	-	1.92	7.03	3.74	6.01	5.28	4.61
TOTAL REPAIRS		11.22	13.10	8.54	13.09	17.70	13.20	10.05	16.40	7.86	19.63	-	10.10	7.76	14.09	7.67	14.94	7.30	17.04	11.93	10.91
REPAIRS (CENTS) PER GAL. FUEL CONSUMED		7.37	6.73	5.57	7.49	9.94	8.48	5.96	6.24	4.39	9.33	6.50	5.79	4.68	9.03	5.82	7.30	4.94	11.29	7.42	6.13
SIGNIFICANT OPERATING COSTS PER LOCOMOTIVE UNIT MILE (Cents)																					
REPAIRS		13.68	11.19	7.63	11.28	18.54	18.20	15.51	11.98	7.38	19.13	13.80	11.31	10.59	16.34	9.68	12.88	10.88	27.19	15.23	11.49
FUEL		17.36	15.19	12.54	17.69	16.36	19.07	23.55	18.01	14.49	21.58	20.79	16.13	20.08	18.33	13.58	14.57	24.22	22.70	20.63	16.68
LUBRICANTS		1.11	1.04	.62	.92	1.06	1.11	1.06	1.28	.55	.74	1.20	1.03	1.08	.65	.81	1.13	.94	1.20	1.04	1.02
TOTAL		32.15	27.42	20.79	32.89	35.96	38.38	40.12	31.27	22.42	41.45	35.79	28.49	31.75	35.32	24.07	28.58	36.04	51.09	36.90	29.19

4-51 Report includes all builders.

DIESEL YARD SERVICE—OPERATING COMPARISON

CUMULATIVE ENDING DECEMBER 31, 1950

RAILROAD CODE	A	B	C	D	E	G	H	J	K	M	N	O	P	Q	R	S	T	U	V	AVERAGE ALL ROADS
OPERATING INDICATORS																				
NO. OF MONTHS DATA COVERS	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	-
AVERAGE AGE OF LOCO'S. (MONTHS)	103	80	71	48	87	60	30	87	78	52	60	88	90	40	110	69	34	58	131	64
AVERAGE LOCO. HOURS WORKED PER MONTH	585	498	549	709	521	516	548	599	550	423	609	493	562	562	569	509	674	545	484	556
% HRS. AVAILABLE OF HOURS IN PERIOD	95.0	92.1	-	92.6	-	96.1	95.4	92.7	91.0	92.1	96.6	94.9	94.8	93.2	-	89.7	96.6	83.0	89.4	92.5
% HRS. WORKED OF HOURS IN PERIOD	80.2	68.7	-	92.6	71.4	70.6	74.9	82.1	75.4	58.1	83.5	67.5	77.1	76.9	77.9	69.7	92.3	75.1	66.3	76.1
AVERAGE HORSEPOWER PER LOCOMOTIVE	745	851	1062	1149	787	895	1066	815	923	1115	900	712	895	625	754	1042	1000	1000	960	890
GALLONS OF FUEL PER LOCOMOTIVE HOUR	6.28	6.13	9.29	7.36	6.91	6.38	8.37	6.22	6.53	9.76	5.91	7.21	7.37	4.56	7.60	8.59	5.65	6.39	8.36	6.88
GALLONS OF LUBRICATING OIL PER LOCO. HR.	.131	.096	.138	.112	.120	.096	.117	.123	.132	.100	.122	.171	.078	.106	.196	.156	.103	.096	.226	.117
SIGNIFICANT OPERATING COSTS PER LOCOMOTIVE HOUR (Dollars)																				
REPAIRS	1.00	1.29	.79	.68	1.07	.95	.47	1.18	1.26	1.54	.59	1.29	.93	1.09	1.30	1.12	.45	1.39	2.05	.98
FUEL	.60	.58	.87	.70	.61	.63	.81	.59	.62	1.03	.59	.66	.68	.49	.77	.81	.59	.54	.69	.66
LUBRICANTS	.06	.05	.07	.05	.05	.05	.06	.06	.08	.04	.06	.07	.04	.06	.08	.09	.05	.06	.14	.05
TOTAL	1.66	1.92	1.73	1.43	1.73	1.63	1.34	1.83	1.96	2.61	1.24	2.02	1.65	1.64	2.15	2.02	1.09	1.99	2.88	1.69
ANALYSIS OF REPAIRS PER LOCOMOTIVE HOUR (Dollars)																				
REPAIRS — ENGINE: LABOR	.30	.25	.27	-	-	.40	-	-	.34	.43	.21	.32	-	.18	-	-	.14	-	.35	.29
MATERIAL	.15	.34	.17	-	-	.12	-	-	.35	.08	.09	.40	-	.25	-	-	.03	-	.28	.22
TOTAL	.45	.59	.44	-	-	.52	-	-	.69	.51	.30	.72	-	.43	-	-	.17	-	.63	.51
REPAIRS — ELECTRICAL: LABOR	.19	.10	.08	-	-	.12	-	-	.11	.20	.08	.11	-	.22	-	-	.06	-	.17	.12
MATERIAL	.09	.05	.08	-	-	.03	-	-	.13	.05	.06	.19	-	.19	-	-	.03	-	.44	.11
TOTAL	.28	.15	.16	-	-	.15	-	-	.24	.25	.14	.30	-	.41	-	-	.09	-	.61	.23
REPAIRS — OTHER: LABOR	.16	.11	.11	-	-	.25	-	-	.22	.54	.08	.14	-	.18	-	-	.13	-	.48	.18
MATERIAL	.11	.14	.08	-	-	.03	-	-	.11	.24	.07	.13	-	.07	-	-	.06	-	.33	.11
TOTAL	.27	.25	.19	-	-	.28	-	-	.33	.78	.15	.27	-	.25	-	-	.19	-	.81	.29
TOTAL REPAIR LABOR	.65	.76	.46	.39	.55	.77	.38	-	.67	1.17	.37	.57	.48	.58	-	.76	.33	.78	1.00	.56
TOTAL REPAIR MATERIAL	.35	.53	.33	.29	.52	.18	.09	-	.59	.37	.22	.72	.45	.51	-	.36	.12	.61	1.05	.43
TOTAL REPAIRS	1.00	1.29	.79	.68	1.07	.95	.47	1.18	1.26	1.54	.59	1.29	.93	1.09	1.30	1.12	.45	1.39	2.05	.98
REPAIRS (CENTS) PER GAL. FUEL CONSUMED	15.86	21.06	8.47	9.23	15.53	14.90	5.63	18.98	19.34	15.77	10.01	17.83	12.57	23.93	17.12	13.04	7.99	21.69	24.51	14.30

4-51 Report includes all builders

Tabulation of the operating costs of nineteen railroads for yard service are given here. The average for all roads is again based on over thirty roads.

"Operating Indicators", the second "Significant Operating Costs", the third "Analysis of Repairs", and finally "Significant Operating Costs per Locomotive Unit Mile".

The report is designed to high-spot the controllable variables and to eliminate uncontrollable fixed expenses. For example, "Crew Costs" are not shown since they are fixed by annual contracts and are very similar between railroads. Also, "Engine House Expense" has been eliminated since there is no uniform method employed in splitting this item between steam and diesel. The statistics have been carefully selected to indicate availability, utilization, work done, and the essential costs of fuel, repairs, and lubricants. Furthermore, repairs have been broken down between "Labor" and "Material" in three classifications; "Engine", "Electrical", and "Other".

It is interesting to note the wide divergence between two somewhat comparable railroads. (Review A and B on freight report). Because Electro-Motive knows the names represented by each symbol, it is possible for them to use the report in carefully evaluating the management decisions which are responsible for adverse results and to assist these managements to bring about an improvement. Here are a number of operating conditions which have been disclosed by the use of this report—and correction started by conference with the railroad managements.

Do You Need Trained Diesel Men ?

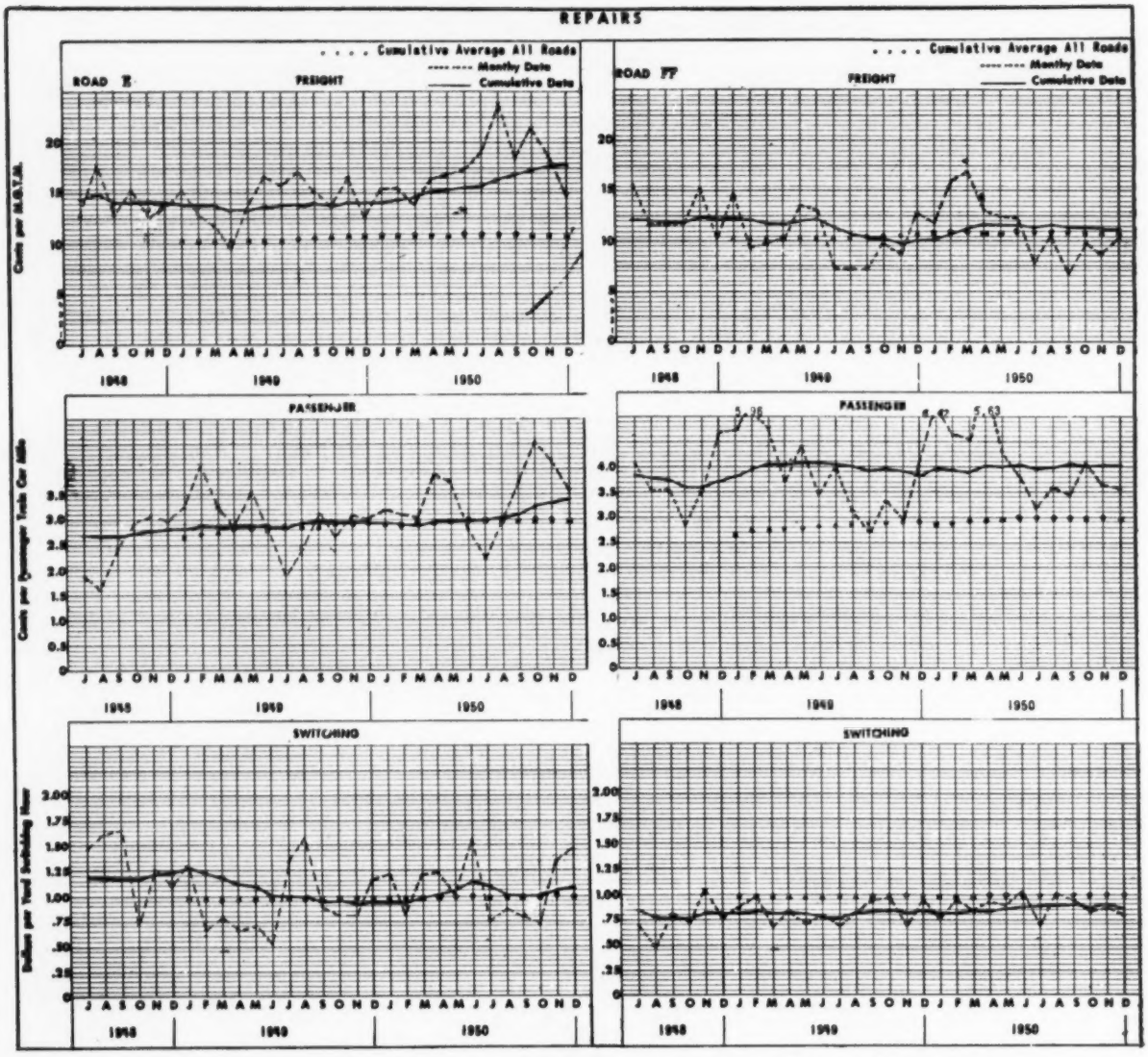
A card to DIESEL POWER AND DIESEL TRANSPORTATION will bring you our listing.

AVAILABILITY

1. *Inadequate facilities for maintaining locomotives.*
2. *Lack of special tools for maintaining locomotives.*
3. *Insufficient supervision of shop forces.*
4. *Need for educational program of shop forces.*
5. *Improper location of maintenance facilities.*
6. *Following steam practice of holding locomotives out of service for repair of components which could be exchanged.*

UTILIZATION

1. *Holding four unit locomotives for maximum tonnage instead of dispatching two or three units with available tonnage.*
2. *Failure to cycle motive-power in orderly sequence for mileage maintenance causing accumulation of heavy repairs.*
3. *Failure to revise schedules and consolidate trains formerly operated on steam schedules to obtain most efficient cycling of locomotives in keeping with traffic demands.*
4. *Failure to utilize locomotives assigned to through runs for local assignments during lay-over periods.*



Graphic comparison of two different railroads on overall operating costs as well as the cumulative average for all roads. Wide variation in costs indicate differences in operating and maintenance procedures and the possibilities for improvement.

REPAIR COSTS

1. *Failure to follow recommended mileage recommendations for overhaul of components.*
2. *Mixing of lubrication oils contrary to recommendations.*
3. *Improper cleaning of filters.*
4. *Repair of components by shop methods instead of return to manufacturer for rebuilding by factory methods.*
5. *Finding unnecessary work to retain people in shops required for steam operation, but not needed for diesel.*
6. *Need for improved tools and equipment for precision maintenance operations.*
7. *Need for education of supervision and staff on correct labor saving methods.*

In addition to these special analyses for the benefit of particular railroads, the "Operating Comparison Report" lends itself to the preparation of supplemental reports of which two may be worthy of comment. The first is a "Rating Report" in which an evaluation is made of the various operational and mechanical factors to determine the relative standing of the participating railroads in their effective use of diesel power. This report is very valuable to EMD in singling out railroads for special assistance in correcting difficulties and in bringing about management decisions for necessary improvement. It is also valuable to record changes in position and thereby chart progress.

A second report is a series of charts showing the monthly and cumulative repair costs for each railroad compared with the average of all railroads, divided into the three classes of service, freight, passenger, and switching. This report is of particular value to the mechanical departments of the railroad and frequently points out the need for corrective actions before they would otherwise have been indicated.

Crankcase Explosion Investigation

*by G. W. Ferguson**

Crankcase explosions, like aircraft disasters, are front page news. People are inclined not to view the occurrence in terms of the thousands of engines that go through their normal lives without any such accident. And, as in the case of aircraft, every effort is made to determine the cause of the accident and to provide against any future occurrence. The contributing conditions do not just go away if ignored or kept quiet. To correct the conditions, the nature of such explosions must be thoroughly understood and, since operation and maintenance practices can contribute to their cause, wide dissemination of such information is in the best interests of the industry.

This is a report on the findings of the Texas Company on this subject. The full report is quite long, and since all of it is of interest, it will be presented in two parts, of which this is the first.

OCCASIONAL occurrence of crankcase explosions has long been a hazard to the safe operation of diesel engines. With the tremendous increase in the use of diesel power in the last ten years, there has naturally been a significant increase in the number of these accidents. Although some of the explosions have been of little consequence, many have resulted in serious injury and death of operating personnel, as well as extensive property damage and loss of the use of equipment.

Realizing the wide-spread interest in this problem, a project was initiated to study the mechanism of crankcase explosions and to investigate the inflammation properties of various oils commonly employed for diesel engine lubrication.

A summary of 104 diesel crankcase and air box explosions based on available literature and accident reports over the last ten years is shown in Table I. Examination of this data reveals that explosions have occurred in all types of railway, marine, and stationary diesel engines from 300 hp. to 8500 hp., 2-cycle or 4-cycle, with or without scavenger blowers, air or mechanical injection, and low-speed or high-speed. Crankcase explosions have also occurred in stationary dual-fuel engines operating on approximately 10 per cent pilot diesel fuel and 90 per cent natural gas. With few exceptions, some overheated part, such as a seized piston, connecting rod bearing, camshaft bearing, etc., was considered the source of ignition. "Flame torching" by lined-up piston rings was reported as the igniting source in one instance, while in three cases a cranckcase explosion in a malfunctioning engine was considered the cause of explosions in normally operating engines alongside. In many instances, large clouds of white smoke issuing from around crankcase doors and openings or excessive engine vibration and noise warned operating personnel of approaching danger; however, some explosions occurred without any outward signs of trouble.

Several reports on crankcase explosions indicate that an initial explosion with sufficient energy to force off crankcase doors was immediately followed by a second explosion of greater intensity, spreading burning oil throughout the engine room. The increased intensity of the secondary explosion was generally explained on the basis that the initial explosion occurred in a slow-burning rich oil/air mixture, and the cooling of the primary explosion gases caused an inrush of air through the blown-out crankcase openings which provided sufficient oxygen to reform a leaner, more explosive mixture for the secondary explosion. In an effort to prevent the occurrence of secondary explosions, some engine manufacturers have installed safety doors designed to relieve the pressure created by the primary explosion and to prevent the inrush of air, thereby reducing the tendency for a secondary explosion. In some installations, these safety doors have performed in a satisfactory manner; however, some accident reports have shown inadequate design and/or installation of these devices.

Although most of the explosions have been explained on the basis that

*The Texas Company, New York, N. Y. Abstract of a paper presented by the author at the Oil and Gas Power Conference of the American Society of Mechanical Engineers at Dallas, Texas.

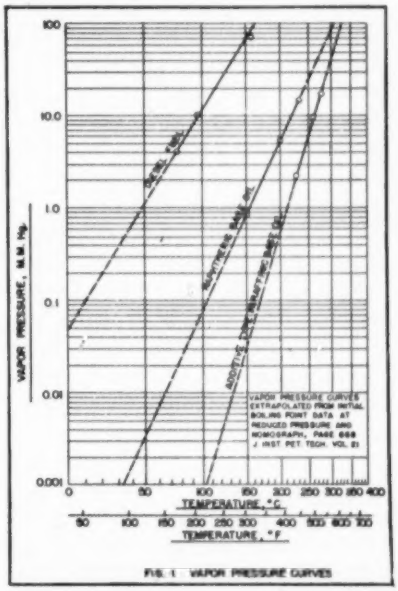
TABLE I

SUMMARY OF CRANKCASE EXPLOSIONS

APPLICATION	ENGINE TYPE (CYCLE)	ENGINE HORSEPOWER	NUMBER OF EXPLOSIONS	CAUSE OF EXPLOSION
RAILWAY	2	900-1350	7 (2*)	Piston
"	2 *	1000-1350	5	Connecting Rod Bearings
"	2	1350	1	Main Bearing
STATIONARY	2	1000-6900	7	Piston
"	2	1200	2	Main Bearing
"	2	1300	1*	Blower Idler Bearing
"	4	750-1200	3	Piston
"	-	-	1	Lined Up Piston Rings
"	2	9000	2	Idler Gear Bushing
STATIONARY (DUAL FUEL)		1600	2	Auxiliary Drive Bushings
"		900	1	Main & Conn. Rod Bearings
		1500	1	Piston
MARINE	2	2000	2	Piston
"	2	900	1	Main Bearings
"	2	900	1*	Blower Bearing
"	2	1700	1	Broken Gear Teeth
"	2	1700-6000	2	Camshaft Bearing
"	2	6000	1	Oil Pump Bearing
"	2	2000	1	Fuel Valve
"	2	1350	15	(Pistons - Main, & Conn. Rod Bearings)
"	4	4000-9000	10	Piston
"	4	7500	2	Idler Gear Bearing
"	4	-	1	Broken Piston Rod
"	-	-	2	Piston
"	-	-	2	-
"	-	-	4	Explosion in Adjacent Engine
MISCELLANEOUS	-	300-1,000	14	Overheated Shaft
"	-	-	2	Explosion in Adjacent Engine

Total 104

*Air Box Explosion.


100
10.0
1.0
0.1
0.01
0.001
VAPOR PRESSURE, M.M. Hg.
DIESEL FUEL
GASOLINES MAY BE
ADDITIVE DEPRESSANT MAY BE
VAPOR PRESSURE CURVES EXTRAPOLATED FROM INITIAL BOILING POINT DATA AT REDUCED PRESSURE AND NOMOGRAPH, PAGE 668 J. INST. PET. TECH. VOL. 21
0 50 100 150 200 250 300 350 400
TEMPERATURE, °C.
50 100 150 200 250 300 400 500 600 700
TEMPERATURE, °F
FIG. 1 VAPOR PRESSURE CURVES

some overheated part was the source of ignition, various investigators have expressed conflicting opinions as to the composition and state of the crankcase atmosphere in a normally operating diesel engine and the mechanism of ignition and subsequent propagation of flame throughout the crankcase atmosphere. Some were of the opinion that the crankcase contained inflammable gases and considerable quantities of oil vapor in addition to the oil sprayed and thrown from the moving parts.

Composition of Crankcase Atmosphere

In view of this difference of opinion, samples were obtained from the crankcase atmosphere of a 600-hp. laboratory diesel engine after 50 hr. operation at a crankcase oil temperature of 250° F. As illustrated in Table II, the non-condensible gases were primarily air as shown by the high oxygen concentration (20.35 per cent O_2). This compares very well with non-condensible gas samples obtained from two 3000-hp. stationary engines A and B which indicated 20.29 to 20.89 per cent oxygen with traces of CO_2. Oil mist samples from the laboratory engine indicated oil/air ratios from 0.007 lb. oil/lb. air with a baffled sampling tube to 1.138 lb. oil/lb. air with a plain sampling tube. The higher oil/air ratio obtained with the plain sampling tube may be more representative of the various size oil particles than was found using the baffled tube since the inertia of the larger oil particles prevented their passage around the baffle plate.

Based on the vapor pressure data illustrated in Figure 1, for representative naphthenic and paraffinic base oils at 250° F, the amount of oil vapor in the crankcase was calculated to be 0.029 and 0.0005 per cent[1], respectively. Although these are approximate values, they are extremely small when compared with calculated values of 0.99 and 0.67 per cent oil vapor in air at the flash point temperatures of these oils. For oils of higher volatility (lower flash point temperature), an increased amount of oil vapor would be present at a crankcase oil temperature of 250° F. It is pointed out, however, that such products would not normally be satisfactory lubricants at these elevated temperatures for reasons other than explosion danger. From these observations, the composition of the crankcase atmosphere of a normally operating diesel engine may be visualized as primarily air charged with particles of oil of various sizes sprayed and thrown from the moving parts. With oils commonly employed for diesel engine lubrication, only negligible quantities of oil vapor are present until the heat evolved by some overheated part or flame vaporizes sufficient quantities of the oil particles to form, *locally*, an inflammable mixture of oil vapor and air. With the continued generation of heat, ignition may take place in the vicinity of the hot spot, which may propagate throughout the mixture by the vaporization and subsequent ignition of the adjacent oil particles.

TABLE II

COMPOSITION OF CRANKCASE ATMOSPHERE

NON-CONDENSIBLE GASES	600 H.P. LAB. DIESEL	3000 H.P. STA. ENGINE A	3000 H.P. STA. ENGINE B
O_2, % Vol.	20.35	20.89-20.29	20.89
CO, % Vol.	0	0	0
CO_2, % Vol.	0	0.1-0.7	0.1
Hydrocarbon Gases, % Vol.	0	0	0
N_2 And Inert Gases, % Vol. (By Difference)	79.65	79.01	79.01
OIL MIST SAMPLES			
Plain Sampling Tube			
Oil, Lb.	0.2824		
Air, Lb.	0.3495		
Oil/Air, Lb./Lb.	1.138		-
Baffled Sampling Tube			
Oil, Lb.	0.039		
Air, Lb.	5.85		
Oil/Air, Lb./Lb.	0.007		

OIL VAPOR IN CRANKCASE	% Vapor at 250°F.	% Vapor at Flash Point Temp.
Naphthenic Base Oil	0.029	0.986 (410°F.)
Additive Type Paraffinic Base Oil	0.0005	0.670 (475°F.)

On the basis of inflammability limits for the mixture of combustible gases found in these samples (approximately 5.0 per cent), the concentration was too low to be in the inflammable range.

The presence of natural gas in these samples and the absence of CO_2 (except for 0.7 per cent in the 650-hp. engine) suggest that most of the piston blow-by occurs during the compression stroke which agrees in part with findings of previous investigators. With increased ring wear and piston clearance, the increase in blow-by of natural gas could possibly result in an inflammable gas/air mixture in addition to the potentially inflammable oil mist/air mixture.

Table III

MASS SPECTROMETER ANALYSIS OF CRANCASE GASES FROM DUAL FUEL ENGINES

Engine	3200 hp.(1)	1220 hp.(2)	650 hp.(2)
Mass Spectrometer Analysis			
O_2, Vol., %	20.8	20.7	13.9
N_2, Vol., %	78.2	76.8	75.5
Argon, Vol., %	1.0	1.0	1.0
CO_2, Vol., %	0	0	0.7
H_2, Vol., %	0	0.1	0.1
Methane, Vol., %	0	1.3	3.5
Ethane, Vol., %	0	1.1	0.2
Ethylene, Vol, %	0	0	0.1
% Combustibles	0	1.5	3.9

(1) Gas injected into cylinders at 700 psi.

(2) Gas mixed with air in intake manifold.

Crankcase Gases in Dual-Fuel Engines

Crankcase gas samples were obtained from these dual-fuel engines to determine if appreciable quantities of inflammable gases were present. Mass spectrometer analyses of these samples are shown in Table III. From these data, it will be seen that approximately 1.5 and 3.9 per cent natural gas was present in the 1220- and 650-hp. engines, respectively. The 3200-hp. engine sample was primarily air, as shown by the high oxygen concentration and absence of inflammable gases.

Composition of White Smoke

In order to determine the composition of the white smoke observed issuing from around the crankcase covers prior to many explosions, careful analyses were made of a sample of smoke produced by oil mist impinging on a surface heated to 1400° F and a sample of the oil mist itself. As shown in Table IV, the composition of the smoke sample was essentially the same as for the oil mist alone except for 0.1 per cent CO_2 and traces of H_2 and H_2S in the smoke samples which possibly indicated some cracking of the oil mist at the heated surface. From this analysis, it may be postulated that some of the oil mist is vaporized by the heated surface and subsequently condsenses to form a *finely divided* oil mist which appears to be white smoke. Thus, it will be seen that vaporization of the crankcase oil by an overheated part and its subsequent condensation

[1] $\text{Per Cent Oil Vapor} = \frac{\text{Partial Pressure Oil Vapor} \times 100}{\text{Crankcase Pressure}}$

may substantially contribute to the formation of an inflammable mixture when the engine is shut down.

Inflammability Limits of Hydrocarbons

Experimental work has indicated that the lower limit of inflammability of condensed mists of petroleum (356-392° F BP), tetralin (404° F BP), and quinoline (401-552° F BP) was essentially the same as for their corresponding vapors; however, flame speed was less in the mists and decreased with increasing particle size. Table V illustrates the lower limit of inflammability for these materials, as well as the inflammability limits for methane, hexane, benzene, octane, and condensed mists of some cutting and quenching oils. Also shown are lower limits of inflammability of a diesel fuel, a naphthenic base oil, and an additive type paraffinic base oil calculated from the vapor pressure of these materials at their flash point temperatures. Although the calculated values were generally higher than the experimental values for similar materials, the data may be employed to approximate the lower limit of inflammability.

Effect of Oxygen Concentration on Inflammability Limits

In addition to the inflammability limits shown in Table V, which were based on concentrations of fuel in air, from tests conducted by the U. S. Bureau of Mines on hydrocarbon gases have indicated that decreasing the oxygen concentration will result in narrowing the inflammability limits until a minimum oxygen concentration is reached, below which flame will no longer propagate. Figure 2 illustrates the effect of oxygen concentration on the inflammability limits of hexane when nitrogen and carbon dioxide are used as diluents.

TABLE IV

MASS SPECTROMETER ANALYSIS OF OIL MIST AND WHITE SMOKE SAMPLES OBTAINED FROM CRANKCASE EXPLOSION TUBE

Composition	Oil Mist Sample (Ignitor Off)	Oil Mist and White Smoke Sample (Ignitor Temp. 1400° F)
O_2	21.2%	21.1%
N_2	77.8%	77.8%
Argon	1.0%	1.0%
F_2	-	Trace
CO_2	-	0.1%
H_2S	-	Trace
	Traces of Heavier Materials Were Present Which Could Not Be Identified.	Traces of Heavier Materials Were Present Which Could Not Be Identified.

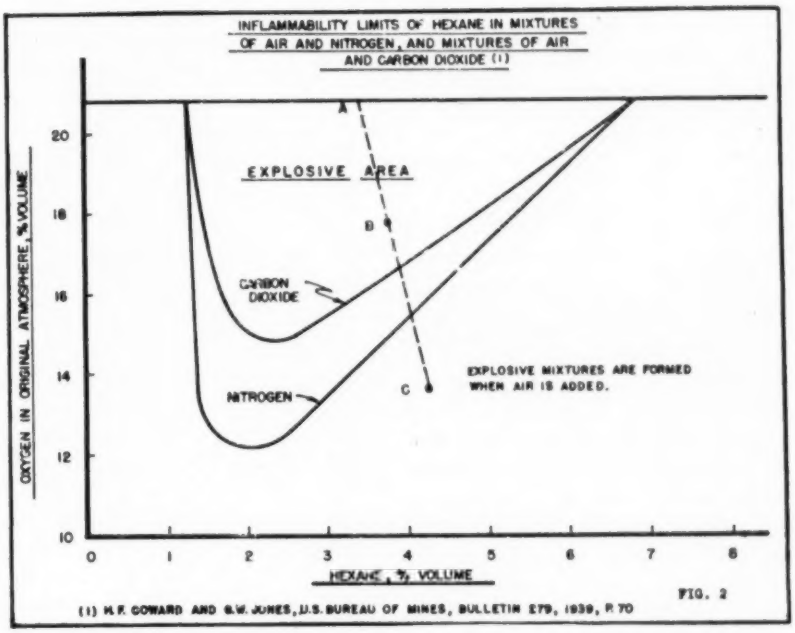


FIG. 2

(1) M.F. COWARD AND G.W. JONES, U.S. BUREAU OF MINES, BULLETIN 279, 1939, P. 70

Changes in Crankcase Atmosphere During Primary and Secondary Explosions

Although hexane is not a constituent of the crankcase atmosphere, in the absence of a similar data on hydrocarbons in the lubricating oil range and in view of the similarity shown above in the minimum oxygen concentrations required in gaseous hexane as compared with mists of higher boiling hydrocarbons, (see Table VI, it is felt that Figure 2 may be employed to explain the changes which may take place in the composition of the crankcase atmosphere during the occurrence of primary and secondary explosions previously mentioned. If the crankcase atmosphere may be visualized as a potentially inflammable mixture of air charged with particles of oil, then referring to Figure 2, the composition of the crankcase atmosphere in a normally operating engine may be represented by point A.

With the ocurrence of an overheated part, the composition may change along line AB due to the vaporization and partial combustion of the oil vapor in the vicinity of the hot spot which increases the fuel concentration and reduces the oxygen concentration. If sufficient energy can be transferred from the overheated part to the oil mist/air mixture before the mixture composition passes outside the explosive area, then a primary explosion may occur.

In the event the primary explosion does not rupture the crankcase and no additional air is supplied, the mixture may fall outside the explosive area to point C because of a further reduction in oxygen concentration and increase in oil vapor. However, if the primray explosion has sufficient energy to force off a crankcase door, then the partial vacuum created by the cooling of the explosion gases will cause an inrush of air to reform an

TABLE V

INFLAMMABILITY LIMITS

MATERIAL	FLASH POINT TEMP. °F.	LOWER LIMIT % VAPOR / MIST IN AIR	LOWER LIMIT % VAPOR / MIST / AIR	UPPER LIMIT % VAPOR IN AIR	UPPER LIMIT % MIST / AIR	REFERENCE
METHANE	-305	5.30	0.031	14.0	0.091	2
PENTANE	-60	1.45	0.037	7.5	0.201	1, 2
HEXANE	-21.6	1.00	0.030	7.0	0.224	1, 2
BENZENE	-11.1	1.40	0.041	8.0	0.235	1, 2
OCTANE	13.3	0.84	0.033	3.2	0.130	1, 2
PETROLEUM (356-392°F., BP)	-	(MIST)	0.037	-	-	3
" "	-	(VAPOR)	0.040	-	-	3
TETRALIN (404°F., BP)	-	(MIST)	0.035	-	-	3
"	-	(VAPOR)	0.044	-	-	3
QUINOLINE (401-552°F., BP)	-	(MIST)	0.060	-	-	3
" "	-	(VAPOR)	0.070	-	-	3
CUTTING OIL NO. 1	268	(MIST)	0.036	(MIST)	0.128	4
" " NO. 2	293	"	0.048	"	0.147	4
" " NO. 2 (ONCE DISTILLED)	230	"	0.055	"	0.235	4
CUTTING OIL NO. 3	-	"	0.042	"	-	4
SPERM QUENCHING OIL	-	"	0.039	"	0.175	4
DIESEL OIL	-	"	0.042	"	-	4
DIESEL FUEL	205	1.32	0.068	-	-	5
NAPHTHENIC BASE OIL	430	0.986	0.102	-	-	5
ADDITIVE TYPE PARAFFINIC BASE OIL	475	0.67	0.0789	-	-	5

[1] Burgoyne, Fuel, 28 (1948) 3.
[2] National Fire Codes, Vol. 1 (1948), 482.
[3] Huber & Wolff, Zeit. f. angew Chem. 36 (1923), 273.
[4] Burgoyne, Fuel, 28 (1948) 146.
[5] Calculated Values Based on Vapor Pressure at Flash Point Temp.

TABLE VI

MINIMUM OXYGEN REQUIREMENT FOR FLAME PROPAGATION

Diluent in Air	Minimum Oxygen Requirement, % Nitrogen	Carbon Dioxide
Fuel		
Methane	12.1	14.6 (1)
n-Hexane	12.1	14.8 (1) (3)
Aviation Hydraulic Oil	12.0	- (2)
Cutting Oil	14.6	16.3 (3)

(1) H. F. Coward and G. W. Jones, U. S. Bureau of Mines Bulletin 279,1939.

(2) Sullivan, Wolfe and Zlesman, Ind. Eng. Chem., Dec. 1947.

(3) Burgoyne and Richardson, Fuel, 28, 1949, p.6.

explosive mixture, which in many cases has resulted in a secondary explosion of greater intensity than the primary explosion. The increased intensity of the secondary explosion may be attributed to an increase in the oxygen concentration and an increased amount of oil in the form of vapor and condensed mist over that available for the primary explosion.

From the above explanation, it would appear that the installation of properly designed crankcase explosion relief valves, which will relieve the pressure created by the primary explosion and close to prevent the entry of outside air, will decrease the possibility of secondary explosions occurring. It will also be realized that the occurrence of an overheated part may not necessarily result in an explosion. If there is sufficient time lag before enough energy can be transferred from the overheated part to the oil mist/air or oil mist-natural gas/air mixture, then the oxygen concentration may be reduced below the minimum required for flame propagation due to partial combustion of the oil vapor in the vicinity of the hot spot. This is borne out by the fact that there have been many instances where the occurrence of an overheated part has not caused a crankcase explosion.

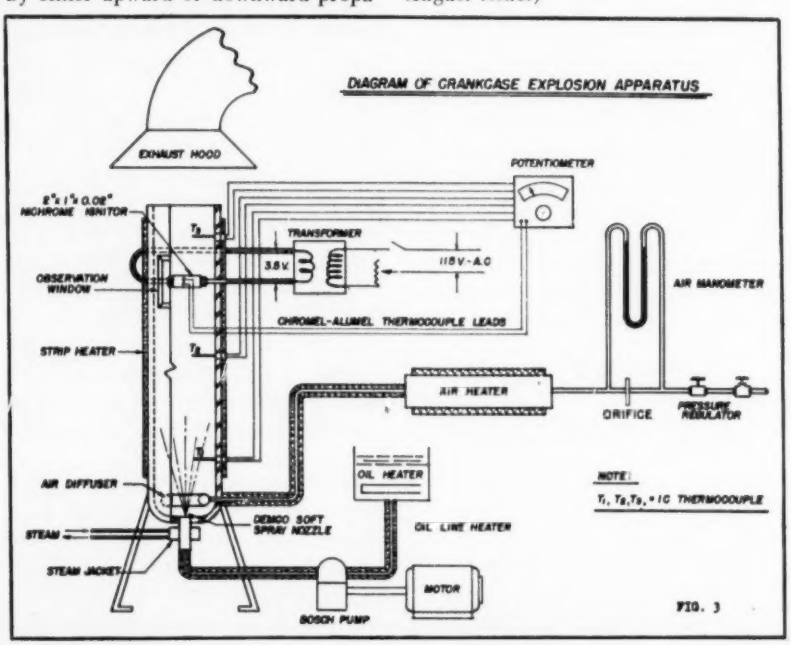
In view of the above considerations, it would appear that measures should be taken to reduce the amount of oxygen in the crankcase. Passing engine exhaust gases into the crankcase to reduce oxygen concentration has been tried in two 5000-hp. marine engines. However, since analysis of the resulting crankcase gases showed 2.8 per cent carbon dioxide and 16 per cent oxygen, this system was abandoned because the oxygen concentration was considered to be above the lower limit of inflammability for this type of mixture. The introduction of compressed nitrogen or carbon dioxide has not been considered practical from an economic and operating standpoint.

Explosion Tube Apparatus

In order to study the mechanism of crankcase explosion and to determine the inflammability properties of various lubricating oils, an explosion tube apparatus was set up to simulate conditions found in the crankcase of a diesel engine. A schematic diagram of the apparatus is shown in Figure 3. In operation, oil, heated to any predetermined temperature, was sprayed vertically upward into an 8-in. diameter steel explosion tube by a steam-heated Demco soft spray nozzle located at the bottom of the tube. Metered air, -heated to any predetermined temperature, was introduced in the bottom of the tube through an air diffuser ring. The temperature of the oil mist/air mixture was maintained at the desired value by strip heaters around the tube. With temperatures, oil delivery and air flow rate adjusted for the desired mixture, low voltage a.c. heating current to a nichrome strip ignitor was turned on. If ignition was obtained, as evidenced by either upward or downward propagation of flame from the ignitor, the process was repeated at progressively lower ignitior temperatures until the minimum ignition temperatures was found. The temperature of the ignitor was controlled by a Variac installed in the primary side of the ignitor transformer and measured by chromel-alumel thermocouple leads spot-welded in the center of the ignitor strip and connected to a potentiometer. Since the thermocouple leads were spot-welded 90° to the direction of current flow and since the natural period of the potentiometer was lower than the 60-cycle a.c. heating current, satisfactory temperature readings were obtained.

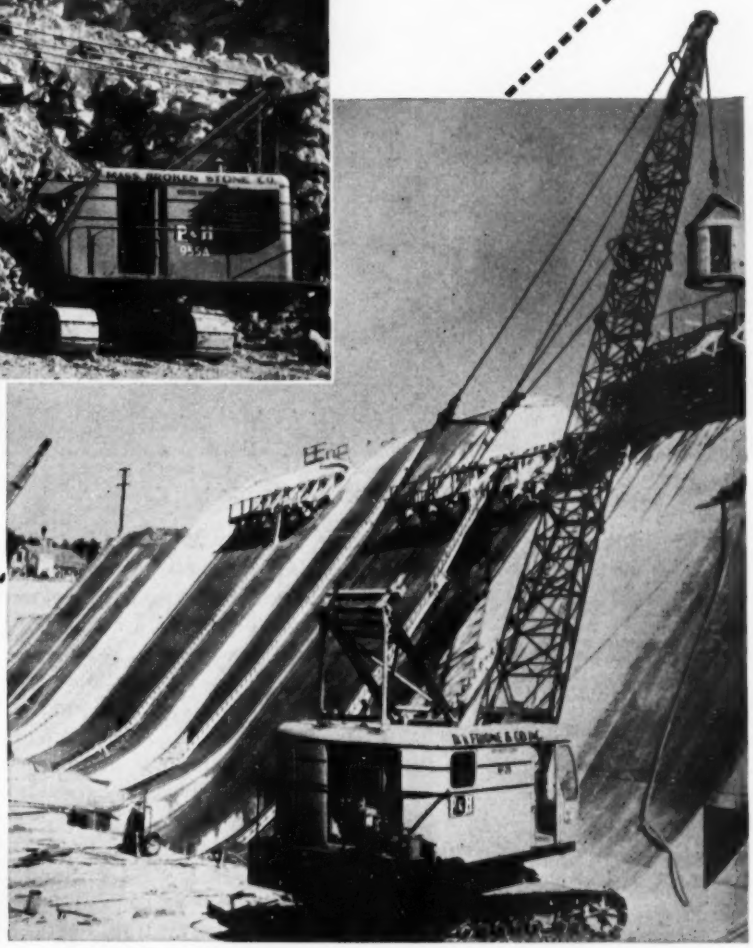
For each run, oil flow, air flow, oil, air, mixture and ignitor temperatures and ignition lag were recorded. Ignition lag was measured from the time the ignitor current was turned on until ignition was observed. If ignition did not occur in 60 seconds, the test was repeated at a higher ignitor temperature, since preliminary runs had shown that there was little probability of ignition with heating time extended beyond one minute. During ignition tests, it was necessary to visually observe upward propagation of flame; however, downward propagation was always accompanied by an audible report.

(This article will be concluded in the August issue.)

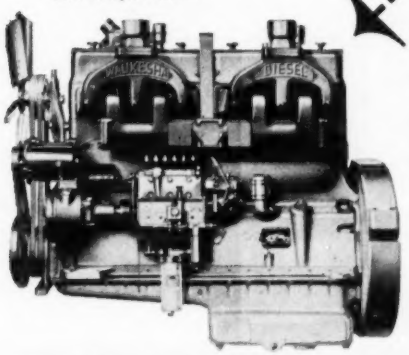


Quarries to Dams

P&H Model 955A Shovel in quarry of Massachusetts Broken Stone Co., Weston, Mass., has a **6-WAKD WAUKESHA DIESEL** as does the **P&H 995A Crane** pouring cement on Mansfield Hollow Dam, Willimantic, Conn. D.V. Frione & Co., New Haven, own the crane.



WAUKESHA Super-Duty DIESEL Model 6-WAKD — six cylinders, 6¼-in. bore x 6½-in. stroke, 1197 cu. in. displacement.



WAUKESHA

137

Diesel POWER

● Trigger quick, but smooth and slick—the Waukesha Super-Duty Diesel snaps right into it, almost the same second the shovel operator puts on the power. It's that *fast recovery* that makes a Waukesha Diesel so different. And you can tell the difference, too — in loads per minute. Operators, contractor-owners, and shovel-makers agree on that. With Harnischfeger Corporation of Milwaukee, Wis., the Waukesha 6-WAKD Diesel is standard equipment on their P & H Model 955A 2½ to 3 cubic yard shovels, draglines, and cranes that are so versatile on such a variety of construction jobs. Pictures show two of them at work.

Like all Waukesha Diesels, this Super-Duty Six has many exclusive design features. Most outstanding is the patented spherical combustion chamber. That's the *why* of Waukesha Diesels' unusual performance—the lively, responsive acceleration, smooth, shock-free operation, clean and complete combustion with high fuel economy and low maintenance. Get Bulletin 1415.

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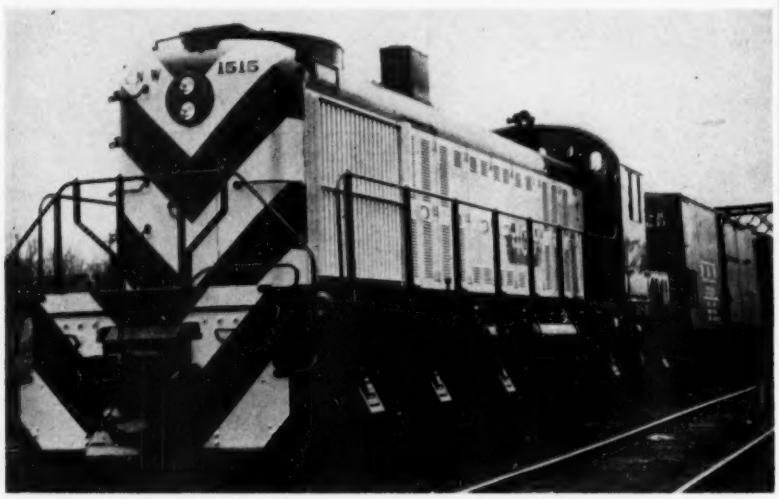
New Products



Alco-GE Road Switcher

The Alco-GE 1600 hp. road switcher is now available with six traction motors for heavy duty drag and hump service and in other applications where high tractive effort is required.

Standard weight is 360,000 lb., but it can also be supplied with total weights of 270,000, 280,000 300,000 and 325,000 lb. The locomotive has a continuous tractive capacity of 78,750 lb. at 5.5 mph., using 74:18 traction motor gearing. Tractive effort is equivalent to 21.8 per cent adhesion with maximum locomotive weight of 360,000 lb. The maximum permissible speed is 60 mph.

This road switcher is the same basic design as the Alco-GE 4-motor road switcher. The two 3-motor, 3-axle trucks are of the drop equalizer, modified swivel type. Truck design is a departure from the usual swivel type. A center plate, offset from exact center, is used as a turning point as in regular practice, but carries only a portion, of the load on the truck as the two loading pads support the remainder. This results in equal axle loading despite changes in load. The loading pads are fixed to the locomotive underframe and slide on load carrying plates located on the truck frame. Both center plate and loading pads operate in oil baths.

Screw Starters

The problem of starting screws in hard-to-get-at places is now simplified, according to Bonney Forge & Tool Works, by their new slot-head screw starters. This tool provides a patented gripping head which holds the screw firmly for starting. The screw is readily released by turning the handle.

The tool is available with metal handles in 4 lengths—2½ in., 5 in, 9 in. and 15 in. It is also available with nylon handles 6 in. and 9 in. overall in length. A set of one each all-metal sizes can be obtained.

Bronze Steel-Backed Bearings

Bronze steel-backed bearings are now available for heavy-duty applications, especially those involving temperature extremes from Beauideal, Inc. Produced by a non-mechanical bonding process, the bronze of the bearing is said to adhere absolutely to the steel backing.

Bearings, using a steel such as nitralloy combined with a high leaded bronze, can be heat treated to 1100°-1200° F. Using a long grain bronze, processing can be accomplished to 1500°-1600° F.

Grinding Wheel Bond

A new grinding wheel bond, known as XL, designed especially for tungsten carbide tool sharpening, has been developed by Chicago Wheel & Mfg. Co. The "XL" bonded wheels are recommended for offhand or precision grinding of carbide tools on milling cutters, broaches, reamers, counter bores, and other similar applications. They are supplied in the straight and cup wheel sizes and steel backs.

New Masonry Drill Bit

The New England Carbide Tool Co., Inc. now has available a cycle carbide tipped drill bit, designed for precision drilling in concrete, glazed tile or other hard masonry materials using a rotary type drill with pressure applied, for holes ¾ in. diameter and up. It is said to do away with the necessity of using a wood template to start holes, as when inserted, it locates and starts a hole. As soon as the hole is spotted, it is removed. This accessory does away with walking of the bit or marring of the surface being drilled, it is claimed.

Dust is expelled as it drills because of the machined-in spiral threads running the full length of the body. These threads make automatic runways for removing dust from the hole as it is cut. Each bit has a port opening for cleaning out the core.

Trolley Hoist

A new addition to the line of Wright Hoists was recently announced by the Wright Hoist Division of American Chain & Cable Company, Inc.

This safeway army-type trolley hoist is made in capacities from ½ ton to 3 tons and is available with a special load bar and either a pair of two-wheel plain trolleys or one plain and one geared two-wheel trolley.

The hoist was designed for service where a close headroom assembly is required. It is light in weight and is said to operate freely around minimum radius curves.

Running-Time Recorder

A new line of running-time recorders has been announced by the Bristol Company. Operating or "on" time of production machinery and other similar equipment is recorded on a chart. The chart record gives the total "on" time in hours, minutes, and seconds for a given period. "Time off" periods are also shown on the chart as well as the time at which they occurred. The recorder magnifies the running-time readings in such a way that the total operating time of a machine can be determined to within a few seconds. They are furnished in models suitable for wall, flush-panel or portable use.

Experimental Small Diesel

Cummins Engine Company, Inc. outlined to the Society of Automotive Engineers recently an 800-lb. diesel engine, said to produce 345 horsepower on the cheapest type of fuel.

The engine is purely an experimental one and not currently scheduled for production. It has a cylinder head with four valves instead of two. This alone has increased its output by 40 hp.

It is claimed that one major objection to diesels has been overcome in the experimental engine with the achievement of a smokeless exhaust, even at high speeds. They report also that it had established the feasibility of substituting aluminum for cast iron to reduce weight.

Non-Melting Grease

Specialty Products Company announced recently a new lubricating grease for use on either plain or anti-friction bearings in all locations in industry where both "cling" and lubricity of the lubricant should be maintained despite high operating temperatures.

It is called "Kantmelt", and does not melt under the highest temperature conditions where lubrication is required. It is a synthetic grease, containing no metallic soaps, fatty acids, filler, water or alkali.

The lubricant should be of value in all phases of ceramic production, foundries, smelting and refining operations, ferrous and non-ferrous metal treating and refining, as well as operations in chemical and food processing.

Silicone Antifoam Agent

Excellent results in defoaming a wide range of compounds have been reported by Polymer Industries, Inc., using General Electric silicone antifoam agent.

Concentrations as low as 75-100 parts per million, blended into high-polymer rubber dispersions, defoam and permit easier utilization of the products, it is claimed. In preparing dry blends of high-polymers, Polymer Industries has found that a light spray with the silicone antifoam prepares the compound for subsequent use without affecting its shelf life.

The silicone anti-foam is a white, odorless liquid that may be dissolved in petroleum naptha, toluol, xylol, or chlorinated aliphatics for addition to foaming manufacturing systems. Because the amount required for a defoaming application depends on a number of factors, the company engi-

Like radar

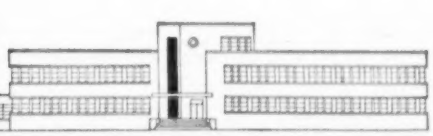
it warns of possible damage to your engine

Vigilant protection . . . 24 hours a day . . . is what PENN Safety Controls give you. At the first hint of excessive water temperature, overheated bearings or oil pressure failure the PENN Control goes into action to prevent damage to your engine!

It will sound an alarm, flash a warning light or stop the engine . . . whichever you choose. This prompt, unfailing action makes it possible to investigate and correct the fault before costly engine damage occurs.

PENN Engine Safety Controls are available in three basic types . . . pressure . . . temperature . . . and combination pressure and temperature. Learn more about this *low-cost protection* for old or new engines. Write for Bulletin E-100. **Penn Electric Switch Co., Goshen, Indiana.** Export Division: 13 E. 40th St., New York 16, N. Y., U.S.A. In Canada: Penn Controls, Ltd., Toronto, Ontario.

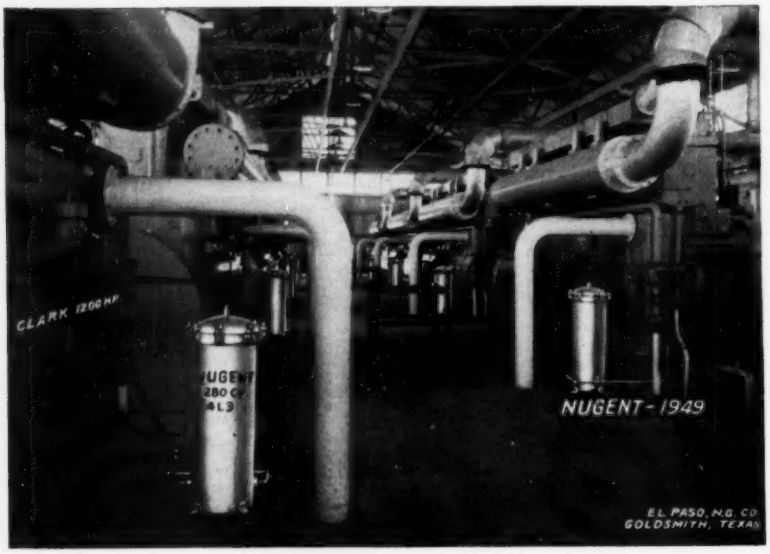
PENN



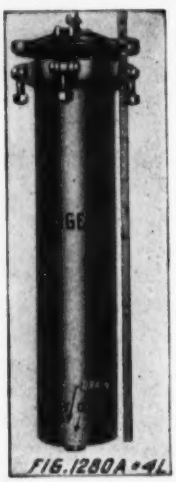
AUTOMATIC CONTROLS

FOR HEATING, REFRIGERATION, AIR CONDITIONING, PUMPS, AIR COMPRESSORS, ENGINES, GAS RANGES

Clean oil means longer compressor life



with NUGENT ABSORBENT OIL FILTERS



Nugent Absorbent Oil Filters get out more of the harmful impurities that get into oil—99.8% by actual test and cleaner oil means that engines, compressors and all machinery will last longer and require less maintenance, while at the same time require less frequent replacement of oil.

Fig. 2180CP, the Nugent Filter type shown above installed on engine-compressor units at the Goldsmith, Texas, station of the El Paso Natural Gas Company, is typical of Nugent depth type pressure liquid filters. The filtering material generally used is a superior quality of cotton waste, wool, excelsior, asbestos or cellulose. No chemicals, bleaches or filtering earths are used. All units have very large capacity for their size. Fig. 1280CP is available in a wide range of capacities. Write for complete information.

Other Nugent filters are available to meet virtually every need.

Wm. W. Nugent & Co., Inc.
417 N. Hermitage Ave. CHICAGO 22, ILLINOIS

OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

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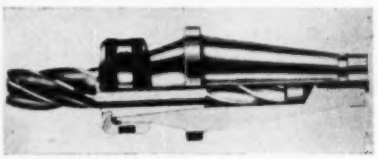
neers recommend that 10 parts per million be tried in initial experiments for process-type applications, and 100 parts per million in product-type application.

Collet Chuck

The Eric S. Johnson Co. is putting out a B & V Swedish designed collet chuck that enables the operator to se-



cure a firm, tight grip with normal tightening pressure. It is claimed that it holds tool absolutely secure, even under such extremely rigorous conditions as deep cuts on tough, alloy steels. The collet loosens simultaneously with the locking nut and milling cutters can be readily changed. The smaller external dimension of the locking nut gives greater accessibility to the work and greater visibility.

New Cummins Engine

Natural gas where available can be utilized in a new engine developed by Cummins Engine Company, Inc.

Designed primarily to take advantage of the plentiful supply of natural gas in the oil producing areas, the new engine is known as the Model LR-600-gas engine. It is classified in the medium speed field, because of its 1100 rpm. rating.

Now in production, it will be used principally for oil well drilling rigs. However, company officials foresee other applications wherever there is an abundance of natural gas, such as in pipeline pumping stations, municipal power plants and cotton gins.

The diesel counter-part of the new gas engine is the Model LR-600. This diesel has a maximum rated horsepower of 300 hp. at a speed of 1100 rpm. and a compression ratio of 13.5 to 1. Conversion units have also been developed to change the LR diesels to gas engines and the LR-600-gas engine to diesel operation. Both of the engines have the same basic parts, all of which are interchangeable.

(*Continued from page 29*)

of this dirty air, all air filters must be cleaned every month, and sometimes every week, if the atmosphere is extremely dirty.

Naturally, proper maintenance depends on the cooperation of management, of operators and of maintenance crews, as well as upon adequate shop facilities.

Shops which are designed and tooled for steam locomotive maintenance service are not suitable for diesel locomotives unless they have been cleaned up and provided with the mechanical and electrical testing and repairing facilities needed for diesel inspection, maintenance and repair work. The shop should be stocked with spare parts to reduce the amount of time locomotives are idle.

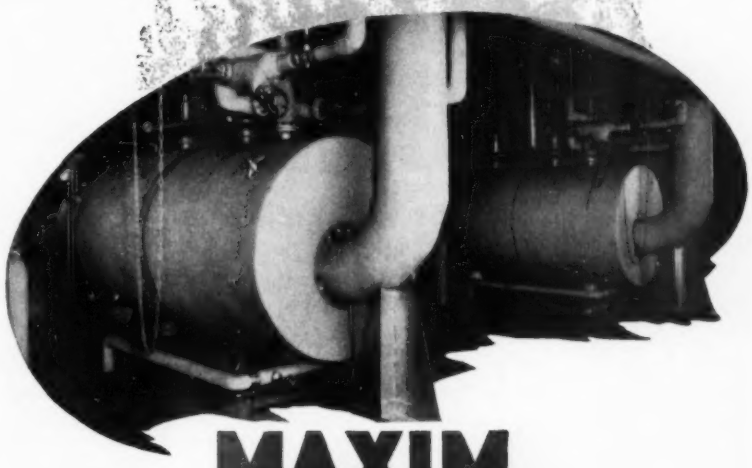
Accurate and complete records should be kept of all inspection, repair and maintenance services. Records should also be kept of the fuel and lubricating oil consumed. High consumption of lubricating oil usually indicates that the time periods between maintenance services are too long.

In passing, it is interesting to observe that one plant is using treated rainwater in the cooling system of its diesel locomotives, because of its absence of scale forming materials.

In addition to diesel locomotives, steel plants use other diesel powered equipment. For example, high lift crawler tractors are used for many services such as dismantling and cleaning out open hearth furnaces and their slag pockets. Crawler boom cranes are used to repair, dismantle, enlarge and modernize building structures and equipment. Some diesel locomotive cranes are used in storage yards for the handling of materials. Small power shovels are lowered into blast furnaces to speed up the removal of debris of old linings.

The future of diesels in the steel industry is good. Some plants are increasing their number of diesel locomotives as fast as the steam locomotives are losing their economic usefulness. And wherever electric current is not available, diesel engines are preferred as prime movers.

IS WASTE HEAT WASTING YOUR MONEY?



MAXIM

HEAT RECOVERY SILENCERS CONVERT WASTE EXHAUST HEAT TO USABLE STEAM or HOT WATER

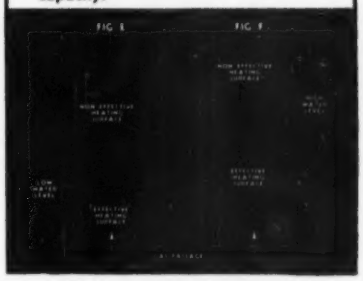
A big Los Angeles Sewage Disposal Plant found that Maxim Heat Recovery Silencers provided all the steam necessary for plant heating as well as heating the sludge — *and from exhaust heat that would otherwise have been wasted.*

Perhaps your own operating expense picture can be improved by this simple and effective way to provide extra steam or hot water for heating or processing operations while at the same time effectively silencing exhaust noise. Our engineering department will be glad to make recommendations.

Automatic Controls

In figure E water is low and there is less effective heating surface (heating surface in contact with water), hence lower steaming rate.

In figure F water is high and gives greater effective heating surface — higher steaming rate. Steam pressure regulated valves control the amount of water to produce desired steam capacity.



Consult MAXIM

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Gentlemen: Please send me your Bulletin on Heat Recovery Silencers

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ROCKFORD CLUTCHES

Pressure Indicator

Two new maximum pressure indicators have been introduced in this country by Dobbie McInnes, Ltd. of Glasgow. They are being manufactured under license from the inventors, Sulzer Brothers of Switzerland.

One type of indicator is for compression pressures and cylinder firing, and the other for fuel pump pressures.

The indicators were developed to provide a reasonably priced but reliable instrument for medium and high speed engines. Unequal loading of the cylinders due to piston ring wear, valve leakage and in the case of diesels, through unequal metering of the fuel, plugged atomizers or other causes are readily indicated.

Universal Wrench

One wrench with 64 socket sizes, it is claimed by the Tubing Appliance Company, will do the work of an open end wrench, crescent wrench, box wrench, socket wrench, ratchet wrench, and crowfoot wrench. It can be used with a torque handle for torque rated fittings. Sockets range from 3/8- to 4-in. in size.

The wrench has an open end, which allows the wrench head and socket to fit on to tubing and down on the fittings. When finished, the wrench is lifted from the fitting, the openings on the head and socket are aligned, and the wrench is removed.

Precision Packings

Periflex, Inc. offers a line of molded packing for hydraulic and pneumatic equipment. They are compression molded under heat and high pressure and are held to precision limits. They are molded from fabric and neoprene compound, said to have a resistance to a wide variety of hydraulic fluids.

Designs available include cup, flange, "U" ring and "O" ring.

New Bronze Bearings and Bushings

An enlarged line of bronze bearings and bushings has been announced by Bronze Bearings, Inc. They range from very small sizes up to sizes as large as 24 in. in diameter, and are plain, flanged, split or any combination. Finishes range from an accurate machine finish for precision application to a semi-finish for rough work. The flanged types are provided not only in all finishes with standard flanges, but also with special flanges to order. All bearings incorporate special lubrication designs to meet individual requirements.

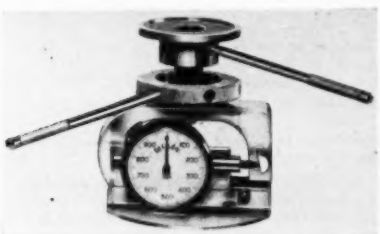
High Temperature, Anti-Corrosive Seal

The Crane Packing Company has developed a new mechanical seal, designated as the Type 9 mechanical shaft seal. It is said to perform effectively under severe temperature and corrosive conditions.

Rather than the leather or synthetic rubber member used in most flexible mechanical seals, the Type 9 incorporates a flexible ring molded from the new plastic, Teflon. The ring enables this seal to combine the chemically inert properties of plastic with the flexibility and positive sealing components essential to effective mechanical sealing. The seal can be employed at temperatures up to 500° F. It has been designed for service on various rotating shaft applications, such as centrifugal pumps, turbines, positive displacement pumps and agitators.

Pressure Gauge Loading Jack

A jacking assembly is now available for the W. C. Dillon & Company, Inc. mechanical pressure gauge. This mechanism now makes it possible to apply compressive loads to the pressure gauge in a straight line and with a minimum of effort.



The pressure gauge has been used alone in checking pressures between vise jaws, moving rollers, clutch assemblies, etc. Its versatility is increased with the new jacking assembly.

New Overload Indicator

Allis-Chalmers distribution transformers are now available with a new overload indicator operated by a thermostatic element in the top oil. The new device operates purely as a signal warning and does not interrupt the continuity of service in any way.

The overload indicator thermostatic element is designed to trip 80° C top oil temperature. This corresponds to 50° C maximum top oil rise above a 30° C average ambient temperature. When the oil reaches the predetermined temperature, a signal light snaps on and stays on until turned off.

The indicator is recommended for systems where more complicated equipment would not be justified. Where records indicate repetitions of overloads, it singles out the units that should be replaced by larger rated transformers.

Pre-Stretched Fan Belts

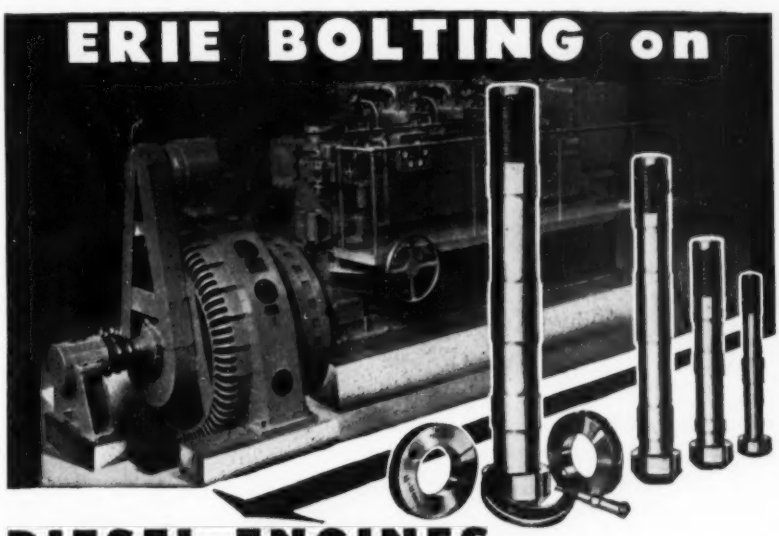
The cord in Sterling International Corporation's new line of fan belts is continuous filament, pre-stretched and normalized. During normalization all cord is thoroughly impregnated with latex so as to eliminate spearation within the cord as well as between the cord and bottom cushion members. Both top and bottom cushions are made of specially compounded heat-resisting rubber. The cover is of long wearing duck, much heavier than ordinarily used. The fan belts are available for all passenger cars, trucks, buses and tractors.

New Literature

Filter Bulletin

A new bulletin which describes the Dollinger line of pipeline filters for air and other gases has been made available by the Dollinger Corp. With emphasis on the "Staynew Double Action Principle" this new 8-page bulletin describes, illustrates and gives applications and specifications for 75 filters, including pressure and vacuum types.

Installation views of the new Series 600 Filters are shown in this latest bulletin. This series is built for air pressures up to 6000 psi. Also shown are installation views of vacuum and absorption types and special models for the removal of carbon black and aluminum oxide.



For over 30 years ERIE has manufactured bolts and studs to the specifications of Diesel Engine builders. This specialized experience gained in working with leading Diesel designing engineers assures you of getting the exact materials and the precise tolerance in bolting desired for your Diesel. Send us your specifications for Diesel Connecting Rod Bolts, Cylinder Head Studs, and other special bolting. Write for new price and data book.

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ERIE, PA.
A SUBSIDIARY OF Barium STEEL CORPORATION

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REPRESENTATION IN PRINCIPAL CITIES

Honeywell Catalog

Minneapolis Honeywell Regulator Company has issued a new 36-page catalog covering electric control potentiometers for both contact and proportional control. Engineering and constructional data, types of control, partial list of available ranges, application data and accessories are described.

Defense Production Record

The Defense Production Administration recently began to issue a weekly bulletin entitled "Defense Production Record", to summarize developments in defense production. It will summarize orders, regulations, recommendations of Industry Advisory Committees and other activities of defense production agencies. The summaries will include a brief of the action, tell where the official text may be obtained, identify other supplementary material, and give the name of the issuing agency.

The objective is to transmit the information to the business community primarily through existing outlets, including trade and business magazines, newspapers, etc. The bulletin will contain no material that had not previously been available to the press and trade publication. Editors, publishers and others concerned were consulted to determine how it could best serve their needs and to make certain it would avoid any competition with existing media.

Diesel Truck Catalog

The Euclid Road Machinery Company has completed a catalog describing its line of heavy duty dump trucks powered by General Motors series 71 diesel engines.

Described are rear and bottom dump models from 10 to 34 tons rated capacity, an 18-cu. yd. scraper and a loader. Engines from 125 to 190 hp. powering these units are pictured as well as cutaway views of the GM 2-cycle diesel, torque converter, and the Allison hydraulic transmission. Listings of Detroit Diesel Engine Division and Euclid distributors and factory branches are included.

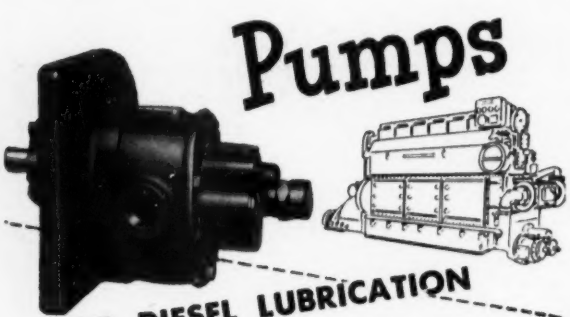
Battery Catalog

Willard Storage Battery Company has issued a new 24-page battery catalog which, along with the rest of the firm's line, describes the "super master" batteries with metalex grids.

Telemetering Folder

A new folder on telemetering has just been published by The Bristol Company. The folder, Bulletin DM-029, contains information on the use of the company's Metameter telemeter for remote measurement and automatic control of variables over distances ranging from a few feet to many miles.

A large number of typical installations of telemeters at gas companies, water plants, pipe line companies, electric utilities, processing and manufacturing plants throughout the country are illustrated and described. Among the applications shown are the remote measurement and control of temperatures, pressures, rates of flow, level of liquids, motion, and various electrical quantities.



THE rotary geared pump shown above is particularly suited for diesel lubrication systems. It has a special flange mounting to facilitate installation together with provision for tachometer drive. Thousands of Brown & Sharpe Pumps are now providing trouble-free service for transfer, lubrication and booster systems. Get acquainted with their reliability and economy. Write for Catalog. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

We urge buying through the Distributor

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THE NEW
FUEL INJECTION SYSTEMS

A 215 page book on all Systems of Fuel Injection Selling for ONLY $1.50 (Outside the U. S. A. $1.75)

This is the finest reference book for the diesel operators, maintenance and service men.

It describes all of the fuel injection systems in use on all modern diesels, including American Bosch, Adeco, Bendix Scintilla, Demco, and the systems produced by diesel manufacturers such as Caterpillar, Cummins, Fairbanks-Morse, General Motors, International Harvester, and Sheppard.

A special chapter is devoted to Fuel Injection Systems for Dual Fuel Engines.

Twenty-five pages on Maintenance alone. Modern equipment for maintenance is described and illustrated.

At the ridiculously low price of only $1.50, no diesel man can afford to be without this book.

For your copy, post paid please, mail this coupon with your remittance.

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new Tray-Type AIR CLEANER
removes and holds more dirt!
RECOMMENDED FOR HIGH-CAPACITY ENGINES on large tractors, rock crushers, power shovels, etc. Large dirt-holding capacity allows longer interval between servicing.
REMOVABLE TRAY SIMPLIFIES SERVICING. Entire tray is quickly removed for cleaning. Multiple screens prevent clogging of condensing element.

IN THIS NEW Donaldson heavy-duty cleaner, the removable multi-screen "tray" and revised oil cup design feeds more of the condensed oil back into the air stream adjacent to the center tube.

A balanced distribution of oil across the entire lower element has been achieved, eliminating both overloaded and "thin" areas.

Extensive tests in the field over a period of five years prove conclusively that the new cleaner has a higher efficiency and a greater dirt-holding capacity. We invite manufacturers to write or call for design data and test reports.

DONALDSON CO., INC. 666 Pelham Blvd., St. Paul 4, Minnesota
Donaldson Co. Ltd. (Can.), Chatham, Ont.

Donaldson AIR CLEANERS

SPECIAL ROPER PUMP POWERS HYDRAULIC BOOSTER FOR STEERING

Among the components that keep this 102 h.p. 27,500 pound bruiser going is a special Roper Pump — the power hydraulic booster control for steering. Engineered to withstand gruelling operating conditions, this pump has proved its worth in years of service in the HD-19. Now Allis-Chalmers is providing the same steering performance in the new HD-15. Allis-Chalmers knows Roper dependability.

Roper "Standard" Pumps also figure prominently as original equipment in diversified installations. They provide a wide selection: sizes 1 to 300 g.p.m.; pressures to 1000 p.s.i.

ROPER *Rotary Pumps*

Send for the Roper catalog and get complete details.

GEO. D. ROPER CORP.
167 Blackhawk Park Avenue
ROCKFORD, ILLINOIS

Thermo Electric Chart

Thermo Electric Company, Inc. has printed a chart showing the applications, calibration symbols, conductors, polarity and Thermo Electric Instrument Society of American and military color codes of thermocouple and extension wires. Resistance tables for these wires are shown on the reverse side.

Torquemeter Bulletin

Baldwin-Lima-Hamilton Corporation has issued an 8-page bulletin describing and illustrating Baldwin SR-4 torquemeters, which are based on measurement with special SR-4 resistance wire strain gages.

The bulletin brings specifications up to date for an increasing number of standard instruments for any speed and many types of service. New dimensional tables, and tables for instrument characteristics and standard graduations for instruments ranging from 100 to 30,000 in. lb. are included.

Bearing Tolerance Booklet

A new 20-page American Standard on Tolerances for Ball and Roller Bearings has been announced by the American Standards Association. It is the second of a series of antifriction bearing standards under development by a committee representing 14 trade associations, technical societies, and the U. S. Army and Navy.

This standard established tolerances and limits of size governing dimensional interchangeability of various types of bearings. Compliance with these tolerances should be checked in accordance with the American Standard Gaging Practices for Ball and Roller Bearings, B3-4-1950.

The booklet contains 15 tables specifying tolerances on the bore, outside, diameter, width, and other characteristics of a bearing in different grades of accuracy required for various bearing applications. Specifications are given also for the maximum permissible variation in diameter between the largest and smallest ball or roller in any assembled bearing; for the hardness of balls, rings and rollers, and for snap ring and groove dimensions.

Power Factor Visualizer

A Power Factor Visualizer that presents a simple explanation of the use of capacitors in solving low power factor problems is available from the Westinghouse Electric Corporation. Prepared in the form of a slide rule type chart, the visualizer makes it possible to follow a hypothetical case involving low power factor and shows how the installation of capacitors can solve this, as well as many similar problems.

The chart explains just what low power factor is, what it means to both the power user and the power supplier, and what benefits can be obtained by improving the power factor in the industrial distribution system through the installation of capacitors.

Machine Shop Catalog

A 2-page illustrated machine shop catalog has been prepared by the Automotive Engine Rebuilders Association.

The shop operations of which there are more than thirty title listings are identified by code which enables the catalog to be used with the individual price sheet. The catalog is available to members at 17¢ per copy without imprint.

Hydraulic Control Manual

A guide on the operation and care of the "Direct Acting" hydraulic control of P&H power cranes and shovels has been released by Harnischfeger Corporation.

The 28-page booklet contains complete information on the hydraulic control system and describes the correct procedure for dismantling, adjusting and replacing parts. Keyed photographs and drawings help identify parts. A 4-page diagrammatic illustration shows the entire hydraulic system.

Welding Manual

A 50-page third edition of the "Manual of Welding Engineering and Design" has been issued by the Eutectic Welding Alloys Corporation. Now included are articles on joint preparation by means of electric arc, additional design information; comparative data, 1951 welding alloy developments, chemical welding aids developed within the past year, and items of procedural information.

Motor Protection Booklet

Co-ordinated protection—interlinked protection of circuits, motors and personnel—is explained in a new 12-page high-voltage combination-starter booklet available from the Westinghouse Electric Corporation.

The booklet stresses the three-way (interlinked) protection for squirrel-cage, synchronous, wound-rotor, and multi-speed motor installations. Three classes of combination motor starters are illustrated, and the type BAL fuse, a component of each starter, is described with illustrations.

Water Conditioning Bulletin

A new leaflet, "The Meaning, Application and Measurement of pH", has been released by Allis-Chalmers' water conditioning department.

Tables reproduced show the different pH values of common acids and alkalies, the intensity of acidity or alkalinity, and the most desirable pH range of industrial waters for different conditions and applications.

Grease Fitting Catalog

Universal hydraulic grease fittings, couplers, swivel couplers, control handle for boosting grease pressures and top oiler for upper cylinder lubrication are described and illustrated in a new catalog published by Universal Lubricating Systems, Inc. The 14-page publication is available from the firm.

The catalog contains a great many illustrations showing the wide range of fittings, etc., which are available from the firm. In addition, an interchange chart is included to enable users to determine what fittings can be interchanged with others.

Honan-Crane Cuts Diesel Overhaul 50%

A report from Lindsborg, Kansas Municipal Power Station says—

"Since installation of Honan-Crane purifiers, improvement in the *condition of oil* and in *engine cleanliness* has been so marked that city engineers plan to pull pistons *only once* every two years instead of every year as has been their custom."

ONLY A HONAN-CRANE OIL PURIFIER GIVES YOU THIS KIND OF PROTECTION

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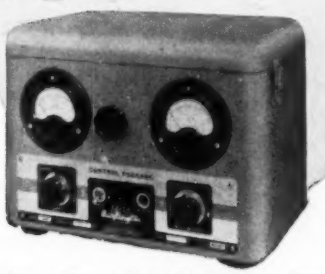
HOUDAILLE-HERSHEY CORP.

Honan-Crane purifier using Cranite (specially processed Fuller's earth) continuously serves the 1200 HP. Model 33FD Fairbanks, Morse dual fuel unit at Lindsborg, Kansas Municipal Power Station

Burlington
CONTROL PACKAGE
TYPE GM { FOR ENGINE GENERATOR SETS



- Automatic and manual voltage regulation.
- Dual voltage potential transformers
- Dual ratio metering transformers.
- Operating controls conveniently grouped on front of cabinet.

The Burlington Control Package, Type GM, housed in a rugged 14 gauge steel cabinet. Contains essential metering and voltage control for portable or stationary engine generator sets. Fills the need for many applications where a separate switchboard is not desired.
Write for Bulletin GM-100.

BURLINGTON INSTRUMENT CO.
DEPT. B-71, BURLINGTON, IOWA

BACHARACH NOZZLE TESTER
for
LARGE SIZE
DIESEL NOZZLES

Check These Features

- Test Pump 1800 cu/mm capacity; ported design. Leak-proof—plunger is chrome steel, hardened, ground and lapped into pump body.
- Nozzle-holding Fixture has spring clamps that accommodate nozzles of different shank diameters. Nozzle is simply "snapped" into position between the clamps.
- Fuel Supply Reservoir (2.5 pint capacity) of durable, transparent plastic; fuel level can be easily observed.
- Micronic-type Filter is noted for its superior cleaning efficiency; is easily replaceable.

Get full particulars — Write for Leaflet 628

BACHARACH
INDUSTRIAL INSTRUMENT CO.
7000 BENNETT STREET · PITTSBURGH 8, PA.

Valve Catalog

A 44 page illustrated catalog describing its complete line of valves is available from Ross Operating Valve Company.

Standard models and modifications are described, together with sectional views, installation data, and diagrams. In addition, several pages are devoted to general reference data, including a non-technical explanation of air valve operation and the difference between various types.

Guidance Manual

A guidance manual intended for engineers who are aiding young men interested in the profession was recently published by the Engineers' Council for Professional Development. The 15-page pamphlet, prepared by the ECPD Guidance Committee, urges members of local engineering societies and sections and chapters of national engineering societies to establish guidance committees to aid high school pupils in determining whether they are qualified for careers in engineering.

The manual explains briefly how to organize advisory committees and to select committee members. It contains suggestions for working schools and students and lists aids useful in counseling. A questionnaire "Shall I Study Engineering?", is included.

Mack Booklet

Mack Trucks, Inc. has announced the release of a 2-color, 8-page booklet entitled "National Security Rides on Trucks". It is designed to meet the needs of educators, commentators, editors, group leaders, etc., by giving them a summary of the importance of the trucking industry to the country's economy.

The booklet includes quotations from high military and government officials as to the vital necessity of trucking, cites the results of surveys into civilian defense and defense economy needs, and gives examples of the growth of the trucking industry.

A 3-point program is emphasized: (1) high priority for the needs of our essential roads; (2) Abolition of obsolete and conflicting state and road restrictions; (3) Full use of highway taxes for better highways.

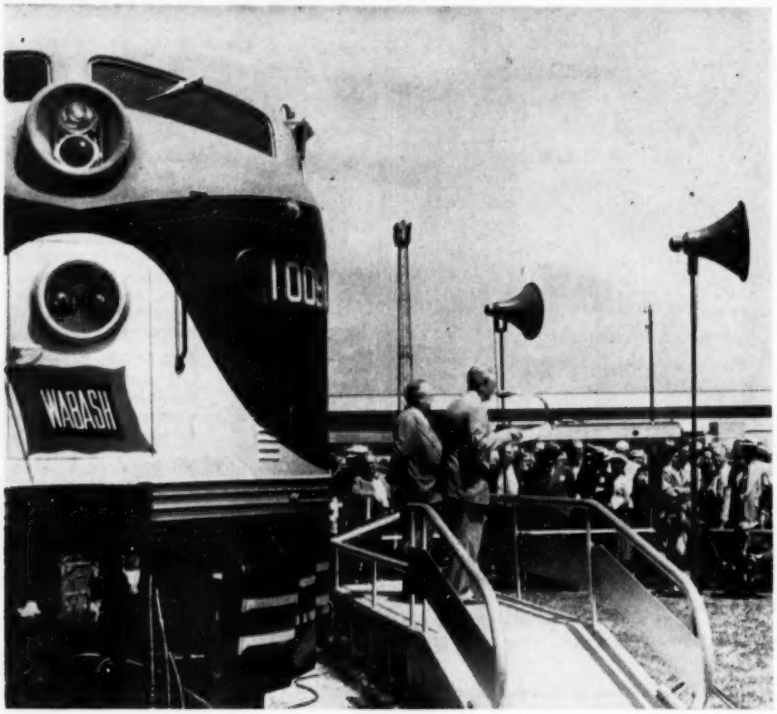
Insulation Report

"Aging Characteristics of Electrical Insulation", a 13-page report by the Office of Technical Service, U. S. Department of Commerce is now available.

It describes a procedure, developed at the Naval Research Laboratory, that uses coils wound and subjected to stresses experienced by motor windings to duplicate physical factors, such as winding stress, bending stress, vibration, electrical stress, etc., which, together with temperature, influence the aging characteristics of insulation. Thus, means are provided for checking all factors which influence insulation life.

The report includes photographs, designs, graphs and tables and sells for 50¢ per copy.

Field Notes



GM Delivers 10,000th Locomotive

Six hundred national railroad executives and Chicago area industrial and civic leaders witnessed commemoration of the 10,000th General Motors diesel locomotive unit in ceremonies at the Electro-Motive Division plant at La Grange, June 14.

The 10,000th unit, a 2,250-hp. passenger locomotive, was delivered to the Wabash Railroad by B. A. Dollens, vice president of General Motors and general manager of Electro-Motive Division, after talks by Charles E. Wilson, president of General Motors, and Charles F. Kettering, research consultant.

In delivering the unit, above, to A. K. Atkinson, president of the Wabash, Mr. Dollens paid tribute to the American railroad men who have used the diesel's advantages to serve the public and thus make possible the production record of 10,000 units within a span of 15 years possible.

An outstanding achievement in manufacturing methods was shown to guests earlier in the day when they toured Electro-Motive's plant No. 2 in Chicago. Here they saw one of the world's newest applications of the conveyor assembly line principle. Complete cab assemblies for freight, passenger, and road switching locomotives are put together on a moving assembly line—first such use of a moving assembly line by a locomotive manufacturer.

Beside cab assemblies, guests saw crankcases for the GM 567 diesel engine, complete electrical control cabinets, plumbing stacks, underframe sections, pilots and platforms, end frames, and final drive gear cases being built at plant No. 2.

Since the first completely Electro-Motive built locomotive (a 600-hp. switcher for the Santa Fe Railroad) went out of the LaGrange plant on May 20, 1936, enough General Motors switcher, passenger, freight, transfer and general purpose locomotives have rolled out of Electro-Motive plants at LaGrange and Cleveland to reach 98 miles, if coupled together. These locomotives totaled more than 13,800,000 hp.

Diesels Go To College

Mack Trucks, Inc., has announced that they have lent 138 hp. diesel engines to more than 20 colleges and universities for teaching and training purposes.

At one university, for example, students took apart and re-assembled a diesel, using only the regulation maintenance manual.

Automotive Engineers Meeting

Plans for peacetime progress in automotive engineering, with overtones of production in war emergencies was featured at the 1951 Summer Meeting program of the Society of Automotive Engineers, held June 3 through 8 at French Lick, Indiana.

Technical papers and round-table discussions were heard on subjects including automatic transmissions, effects of combustion chamber deposits, methods of estimating fatigue life and design and production problems related to military vehicles and aircraft.

Also considered were methods for evaluating loads and stresses in machine design, diesel engine combustion systems, and a new experimental high-speed, low-weight diesel engine.

Shift to Diesels Frees Real Estate

The complete dieselization of the Boston & Albany Railroad has given Boston civic and business leaders a tract of 28 acres of undeveloped land in the heart of the uptown business district on which to plan for commercial expansion.

The railroad announced that its freight and passenger yards in the Back Bay district were up for sale. This includes rights over the main line, since diesel locomotives could be operated through a tunnel.

New Farr Factory

The Farr Company has moved from its old plant in Los Angeles to a new main factory and office building in El Segundo, California.

The new plant, necessitated by business growth, has more than double the former manufacturing area. Facilities include offices, a research laboratory, an engineering and designing department, and manufacturing areas.

Worthington Installation

Barton Mines of North Creek, New York, producer of abrasive garnet, has ordered a SDH-6 diesel engine with a 580 kw. electric machinery generator and auxiliary equipment from Worthington Pump and Machinery Corporation.

This order for an 865-hp., 12 by 14, 600-rpm. unit will make the second supercharged diesel engine used to increase the present plant generating capacity.

Glasgow Locomotives

The North British Locomotive Company of Glasgow has acquired the British rights in the Voith system of diesel hydraulic transmission. The Voith system has been used considerably in Germany.

The company has completed the first of a series of shunting locomotives for yard and short distance work. It is a 32 ton, 200-hp. locomotive, and it is hoped that ultimately a main line unit of 1500-hp. or higher will be produced.

New NBS Laboratory

A new National Bureau of Standards laboratory center at Corona, California commenced limited operations recently and will be in full scale operation by September. The most important activity will be the development of guided missiles.

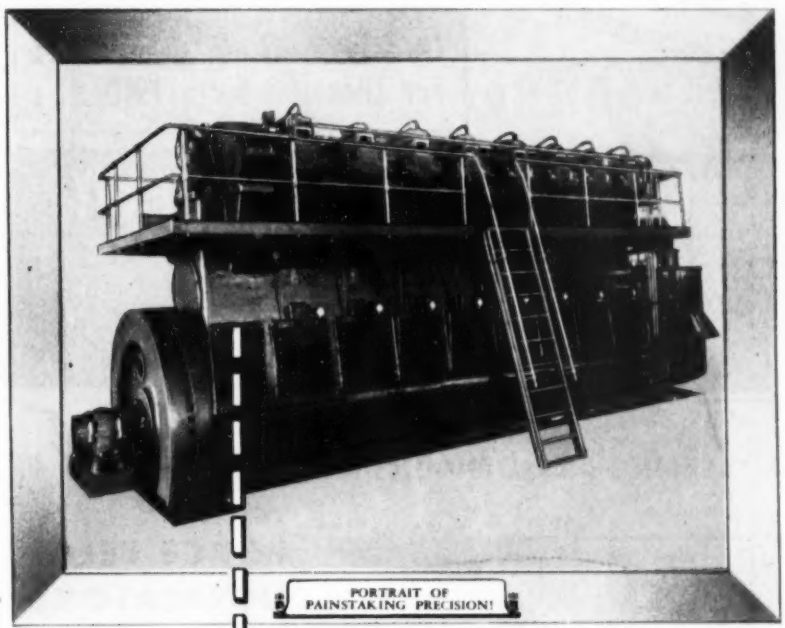
The site for the new center was transferred to NBS by the Department of the Navy because of the Bureau's urgent need for new facilities. About 22 buildings are being renovated to accommodate activities being transferred from Washington.

New Pennsalt Department

The Pennsylvania Salt Manufacturing Company has formed a new sales department to serve industry and business in maintenance work, from heavy duty cleaning of railroad equipment to the cleaning of walls and floors in office buildings and institutions.

The new department, designed as the Maintenance Chemicals Department, is headed by Horace F. McIntyre, a member of the company since 1943 and formerly a sales representative, district sales manager and then product supervisor in the Special Chemicals Department.

To the Maintenance Chemicals Department has been assigned all sales and service work on products for maintenance, as differentiated from products used in manufacturing processes. Thus, specialties for maintenance of railroad equipment, formerly handled by the Special Chemicals Department, have been assigned to the new department.



You Can Count on Fulton Diesels

For Dependability . . For Economy

Smoother-running • peak operating efficiency • greater fuel economy • less wear and tear • quick, easy replacements that save time and money . . .

Because **. . . even the heaviest parts of every Fulton Diesel are machined to such close tolerance that they are completely interchangeable.**

FULTON

FULTON IRON WORKS COMPANY

SAINT LOUIS 14, MISSOURI

Consult ELLWOOD on all Your Forging Requirements

Quality Precision Crankshafts For Diesels — Since 1910 . . .

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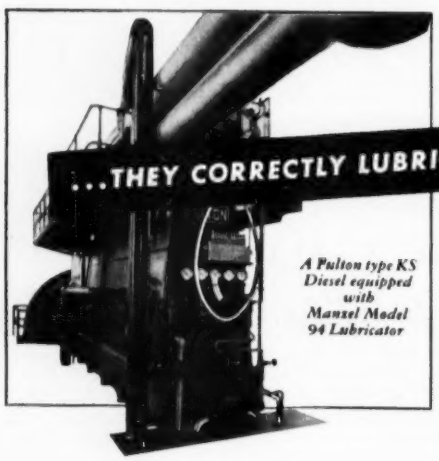
CRANKSHAFTS · CONNECTING RODS
MACHINE FORGINGS

ELLWOOD CITY, PENNA.

LEADING DIESEL ENGINES HAVE *Manzel* FORCE FEED LUBRICATORS



...THEY CORRECTLY LUBRICATE EACH POINT

A Fulton type KS Diesel equipped with Manzel Model 94 Lubricator

Manzel Lubricators supply the *exact* amount of oil needed at each wearing point, reducing oil consumption as much as 90%.

They are furnished as standard equipment on leading makes of engines, and machinery. Or they can be installed on your present equipment.

We will gladly have a Manzel lubricator engineer submit recommendations without obligation. Just write...

Why it Pays to Select Manzel Lubricators

- THEY LENGTHEN THE LIFE OF MACHINERY
- THEY ARE AUTOMATIC AND TROUBLE-FREE
- THEY ELIMINATE "DOWN TIME"
- THEY CUT OIL CONSUMPTION UP TO 90%

Manzel 315 BABCOCK STREET BUFFALO, NEW YORK

Nordberg Distributors

Nordberg Manufacturing Company has recently appointed three new distributors for their 4FS 4-cycle, 1-and 2-cyl. diesel engines. They are as follows: Houston Engine & Pump Co., Houston, for the Gulf Coast of Texas and territory within a one-hundred mile radius of Houston; O'Keefe Motors, Inc., Trenton, for the northern half of New Jersey; Midwest Utilities Power Equipment Corp., Chicago, for northeastern Illinois. Indiana and western Michigan.

Baldwin-Lima-Hamilton Contract

A contract for four 35,000 hp. hydraulic turbines, of the adjustable blade type, which will rank among the largest in physical size ever produced in this country, has recently been awarded to the Baldwin-Lima-Hamilton Corporation by the U. S. Army Engineers. The value of this contract is almost four million dollars.

These units are being built for installation in the Old Hickory Power Plant located on the Cumberland River in Tennessee.

New Purolator Plant

Purolator Products, Inc., will increase production in the early Fall when a new and modern factory will be opened in Ringtown, Pa. It is a community-built manufacturing building recently erected under the leadership of the Chamber of Progress of Shenandoah, Pa. A one-story building, it contains 40,000 sq. ft. of floor space.

Canadian Westinghouse

A wholly owned subsidiary, the Canadian Westinghouse Supply Company, has been formed to distribute products of the Canadian Westinghouse Company, Ltd.

The new company will establish facilities in principal trading centers throughout Canada and will sell, in addition to Westinghouse merchandise, other lines such as cable, conduit, and fittings not manufactured by the Canadian firm. In this way, builders, contractors and small and medium industry will be able to purchase complete lines at one location.

National Supply Sales Divisions

To service the expanding oil and gas industry requirements in the Southwest, The National Supply Company recently announced the creation of two sales divisions.

The Southwest Divisions, with headquarters at Fort Worth, consists of 20 stores operated in an area comprising Northern Louisiana, Southern Arkansas, East Texas, North Texas, West Texas, New Mexico and the Pan Handle. The Gulf Coast Division, with headquarters in Houston, will be comprised of 15 stores in Mississippi, Southern Louisiana and the entire Gulf Coast region. Previously, the entire area had operated as one division.

GM Proving Ground

General Motors has extended its proving ground facilities by purchasing 2280 acres of desert land 34 miles southeast of Phoenix, Arizona, near Williams Field, U. S. Air Force.

The tract will be used for hot weather testing of cars, trucks and buses. It also will be used for the development testing of military vehicles, including tanks. The purchase provides the corporation with two proving grounds in two climates — this and the original 2300 acre ground near Milford, Mich. Thus GM now own 4500 acres for automotive test use.

Worthington Pumps for Water Treatment Plant

The Southwest Water Treatment Plant of Miami, Florida, now under construction, has recently ordered four diesel engine driven pumping units from Worthington Pump and Machinery Corporation.

Four 16-LCS-4 horizontal centrifugal pumps are to be driven by SDR-5 diesel engines of 825 hp. each, through J-6 speed increasing gears. One of these engines is arranged so that it can be disconnected from the pump and coupled to a 750 kva. electric machinery generator.

The plant, to be completed in 1954, will supply water for Miami at an initial capacity of 40 million gallons per day, and an eventual capacity of 80 million gallons per day.

European Competition in Locomotives

At a transportation conference at the Summer General Meeting of the American Institute of Electrical Engineers held recently, G. Huldschiner, New York electrical engineer, claimed that future export of American locomotive may be "handicapped by strong European competition." He said that European locomotives are not only lighter, but can be built cheaper, mainly because of the wage differential.

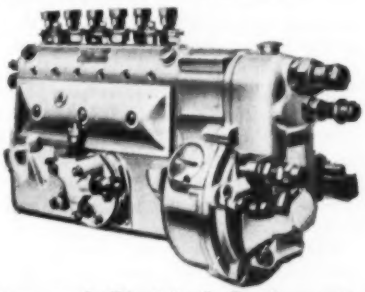
Among the European countries only Spain figures as a potential customer, but South America, South Africa and India are markets open to competition, he stated.

Confidence Abroad

Transport operators all over the world have learnt to trust this sign.

In any language the letters on the C.A.V. sign stand for first-rate service facilities, maintained by highly-trained craftsmen, using special precision equipment.

Wherever vehicles fitted with C.A.V. Fuel Injection Equipment are exported — whether to Trondheim, Santiago, Hong-Kong or Sydney — there's a service agent or depot to give it the specialist attention needed for such high-precision equipment.



C.A.V. Fuel Injection and Electrical Equipment

Service Depots throughout the World

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TELLITE

Low Air Brake Pressure

High Water or Oil Temperature

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Generator

VISUAL
WARNING SYSTEM
for Gas and Diesel Engines

This unique signal system gives a virtually foolproof warning whenever there's engine trouble . . . low oil or air brake pressure, high water or oil temperature, or generator failure. And it points out the trouble before expensive damage is caused.

Under normal conditions, a pilot light glows steadily. But when something goes wrong, it flashes brilliantly. It even indicates when the system itself is not operating. TELLITE is available with one flasher, or individual flashers connected to each point of contact to tell just where the trouble is.

This inexpensive trouble shooter is ideal for trucks, buses, tractors and industrial engines. Write for complete information. ROCHESTER MANUFACTURING CO., INC., 34 Rockwood St., Rochester 10, N.Y.

ROCHESTER
Manufacturing Co., Inc.
DIAL THERMOMETERS · GAUGES · AMMETERS

New GE Departments

Six manufacturing affiliates of the General Electric Company recently became departments of the parent company.

The affiliates are Carboloy Co., Inc., with headquarters in Detroit; General Electric X-Ray Corp., Milwaukee; Locke, Inc., Baltimore; Telechron, Inc., Ashland, Mass.; Monowatt, Inc., Providence, R. I.; and the Trumbull Electric Manufacturing Co., Plainville, Conn.

Cummins Dealerships

Cummins diesels are now being sold and serviced in Connecticut by Cummins Diesel Engines of Connecticut, Inc., formerly Cummins Diesel Engines of New England, Inc., with headquarters in Hartford. There has been no change in management or personnel. An increase in facilities is planned, by adding 7500 sq. ft. to the shop area, and additional tools and equipment.

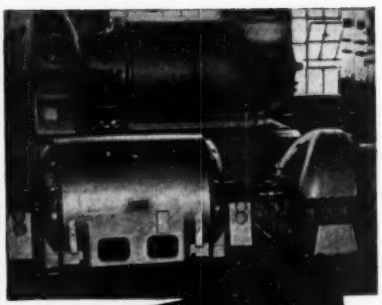
The service and sales of Cummins diesels for Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island will be handled by Cummins Diesel of New England, Inc., at Boston.

New Refinery for Sarnia

Engineering of several major processing units for Canadian Oil's new 18 million dollar refinery at Sarnia, Ontario, has progressed from the planning stage to the production phase and construction started sometime in April. Canadian Oil Companies and Canadian Oil Refineries will own and operate the refinery.

Completion of the plant, for which Canadian Kellogg will design and erect combination Fluid catalytic cracking and catalytic polymerization unit as well as special fractionating equipment to produce butane and propane, is scheduled for 1952.

The combination unit, first of its kind to have the new Orthflow catalytic cracker operating in combination with cat poly, will produce high-octane stock for both aviation and automotive gasoline. Gas oil feed for the cracker will be produced from 20,000 bpd. of Alberta crude.



Give YOUR Equipment that New Look!

SPRUCE up your diesels, generators, other heavy equipment by giving them a quick rub-down with Oakite Renovator.

Oakite Renovator, solvent emulsion type cleaner, is easy to apply by cloth or sponge. Goes after grime, oil, soot, other surface dirt in a hurry. No rinse necessary—just polish with a dry-cloth to bring out high paint luster. Completely safe on painted surfaces, Oakite Renovator presents no fire hazard because its solutions are water-mixed.

Ask your local Oakite Technical Service Representative for free on-the-spot demonstration. Ask him about other fast, thorough, low-cost Oakite cleaning methods too. Or write for "Power Plant Cleaning" Digest. FREE!

OAKITE PRODUCTS, INC.
22C Thames Street, NEW YORK 6, N. Y.
Technical Service Representatives Located in Principal Cities of United States and Canada

OAKITE
SPECIALIZED INDUSTRIAL CLEANING
MATERIALS · METHODS · SERVICE

Specify
COLUMBIA
A. C. and D. C.
GENERATORS
• For Coupled Service
• For Belt Drive
• Single or Two Bearing

Columbia, with its years of experience, brings to generator set assemblers a wide line of performance proved, sturdily built, A. C. and D. C. Generators.

AC Generators: 6¼ to 1000 KVA
DC Generators and Exciters: 2 to 300 KW

•

Write for information. Our Engineers will be glad to review your requirements.

COLUMBIA ELECTRIC MFG. CO.
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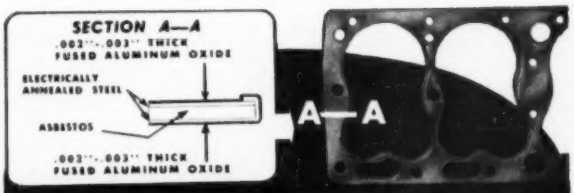


FOR A LASTING, PERFECT SEAL IN HIGH COMPRESSION ENGINES
Use Only

Fitzgerald Metallic Aluminum-Fused-Oxide Steel Asbestos Gaskets*

Grease Retainers — Cork Gaskets

FITZ-Rite* Treated Fiber Gaskets for oil, gasoline and water connections. Complete Sets For Motor Rebuilders. *S. M. Reg. Pending

FITZGERALD Gaskets
SINCE 1906
The Fitzgerald Manufacturing Company
TORRINGTON, CONNECTICUT

There's a Fitzgerald Gasket for every Engine

Military Equipment Repair Policy

The Munitions Board has recently announced a plan to use commercial facilities for depot-type maintenance of Army, Navy and Air Force equipment. Current equipment maintenance needs are being surveyed, and plans will be made with commercial firms to handle the maintenance work. One purpose is to minimize additional military shop construction and investment in tools and equipment. Military repair facilities will be reserved for work that cannot be readily done commercially. This new policy is expected to assist small business and to broaden the industrial base of military supply.

GM Plant

The program for the building of a plant containing 500,000 sq. ft. was announced recently by the Delco Appliance Division of General Motors.

The one story structure is being erected for the manufacture of defense products, particularly small motors used by the Air Force.

Organizational News

Nordberg Appointment

The appointment of Thomas B. McMeekin as sales and service engineer, Heavy Machinery Division, San Francisco office, is announced by Nordberg Manufacturing Company. He will assume the duties of George Lienhard who has resigned.

Chain Belt Vice President

Chain Belt Company of Milwaukee has recently elected L. B. McKnight to the newly created position of Executive vice president of the company.

Mr. McKnight has served in various managerial capacities since joining the company in 1927, and has been a vice president and director since 1948. He is currently president of the National Association of Conveyor Equipment Manufacturers and is also a member of the conveyor industry advisory committee to the National Production Authority.

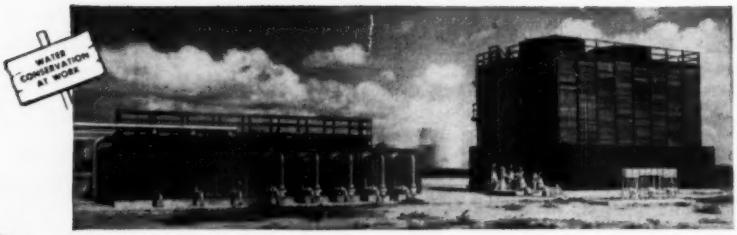
Midvale Elections

At its annual organization meeting held recently, the Midvale Company elected the following officers:. Richard T. Nalle, President; Lewis W. Metzger, Executive Vice-President; A. R. Gaus, Vice President in Charge of Sales; A. O. Schaefer, Vice-President in Charge of Engineering and Manufacturing; Charles E. Acker, secretary and Lloyd R. Lowen, treasurer and assistant secretary.

National Supply Manager

Frank L. Johnson has recently been appointed manager of export sales of The National Supply Company's Engine Division, with headquarters in New York.

Mr. Johnson is a graduate of the California Maritime Academy. He has been employed by the Coast and Geodetic Survey, the American President Lines, and by Frazer and Hansen, Ltd., where he handled export sales of diesel engines and other industrial equipment.



"That Pritchard Tower Is Sure Doin' A Job For Us" — Says Refinery Superintendent.

We got a tough assignment back in '49. Our customer needed a tower which would cool more than 4,000 gallons of recirculating water per minute from 105° down to 85° F., only 5° above the ambient wet bulb temperature. His entire process depended completely on 85° water—there could be *no* excuses! Could we do it?

We could, and we did. A few months later the Pritchard series "J" Induced Draft Cooling Tower with separate coil shed pictured above was put into operation.

Today, according to the plant superintendent, this tower is consistently equalling or exceeding the design performance in accordance with the test procedures outlined by the ASME, with the operating crew taking their own test readings.

Why don't you, too, find out about the advantages of using Pritchard Cooling Towers in your plant? Consult your nearby Pritchard representative for full information.

EQUIPMENT DIVISION
J.F. Pritchard & Co.
Dept. No. 129 908 Grand Ave., Kansas City 6, Mo.

Write for Bulletins

District Offices: HOUSTON • ST. LOUIS • CHICAGO • PITTSBURGH • TULSA • NEW YORK
Representatives in Principal Cities from Coast to Coast

Prest-O-Lite Manager

Curtis W. Young has been made manager of the West Coast Sales Division of the Prest-O-Lite Battery Co. He had been a district sales representative in the San Francisco area for several years.

Mr. Young will make his headquarters at the Oakland, California plant, and be in charge of salesmen covering the entire west coast and Rocky Mountain region.

Link-Belt Promotions

Ralph W. Rausch has been appointed consulting engineer of Link-Belt Company. His headquarters will continue to be at the Pershing Road plant, Chicago, of which he became assistant chief engineer in 1933 and chief engineer in 1947.

Joseph J. Richard, formerly executive assistant chief engineer of the Pershing Road plant, has been appointed chief engineer of this plant to succeed Mr. Rausch.

Sterling President

Kenneth S. Thomson, formerly executive secretary of the Cleveland Association of Credit Men, was recently elected president of the Sterling Engine Company, Buffalo, N. Y.

Born in Scotland, Mr. Thomson came to the United States 35 years ago and made his home in California. He has successively been engaged in the food ranching and ceramic industries in addition to serving as financial advisor on the boards of a number of manufacturers. In World War I, he served with the U. S. Engineers in France and was with the Valuation Division of the American Commission to Negotiate Peace at Paris in 1919.

Rock Island Changes

A. B. Enoch, general solicitor of the Rock Island Lines, retired recently after 41 years of service, and was succeeded by Bruce Dwinell, general attorney.

Other promotions in the law department include Eaton Adams, general attorney to assistant general counsel, and Thomas I. Megan, assistant general attorney to general attorney.

Socony Appointment

Warren A. Beman, staff member in charge of textile work for the chemical products division of the Socony-Vacuum Oil Company, Inc., has been appointed to direct chemical products development for the company.

Previous to being transferred to the company's executive offices in New York, he worked in refinery engineering, the development section of the laboratories, and in field technical sales and service.

Mack Director

John L. Wilson, vice president and director of Anheuser-Busch, Inc., has been elected a director of Mack Trucks, Inc.

Mr. Wilson was previously long associated with Mack, having joined the organization in 1922. After 22 years with Mack, he joined the St. Louis Public Service Company as president and remained in that capacity until his recent election as vice president and director of Anheuser-Busch, Inc.

Allegheny Ludlum Plant Manager

Robert T. Eakin, metallurgical engineer who joined Allegheny Ludlum Steel Corporation as a student trainee in 1940, was appointed manager of the company's largest plant, at Brackenridge, Pa., succeeding George Evans, who became special consultant to the vice president in charge of operations.

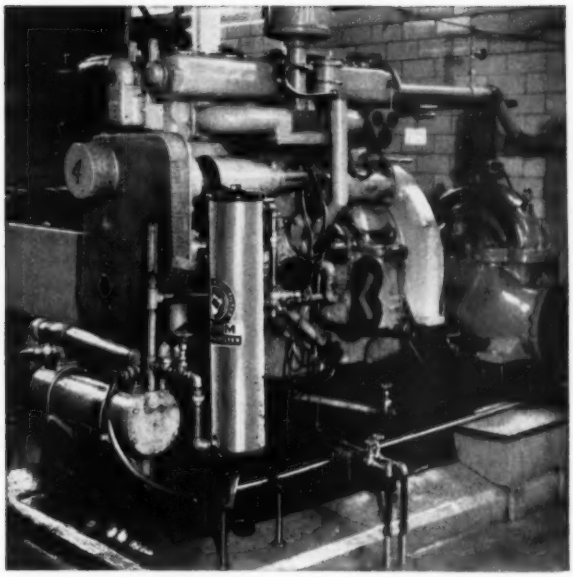
Mr. Eakin is a graduate of Penn State. He has been manager of the Carbide Alloys plant at Ferndale, Michigan and assistant manager of the Brackenridge plant.

Westinghouse Promotions

H. E. Grout was named works manager of the Westinghouse Electric Corporation's Small Motor Division, with responsibility for all manufacturing activities of the division, including the several plants and their equipment. He has served 26 years with the corporation.

W. P. Bell was promoted to manager of manufacturing for the Lima plant and will be in charge of all line manufacturing activities. He served last as superintendent of quality control.

C. F. Herbold was appointed superintendent of quality control to take Mr. Bell's place. Previously he was superintendent of manufacturing planning operations of the Lima and Cleveland works.



Fram Filter Installation on Murphy Diesel at New London, Conn., Waterworks

FRAM Filters Assure Dependable Diesel Operation at Pumping Station

PUMPING STATION Supervisor Walter F. Mahoney says words cannot express the excellency of Fram Filters. This station operates 24 hours a day, 7 days a week, pumping water from reservoir into large storage tanks which supply New London, Conn., with water. Reliable operation is vital. Without it, the city would be without water. Fram Filters remove sludge, grit, abrasives and other impurities from lubricating oil, prolong engine life, cut down-time and maintenance costs.

FRAM Filcron Filters Do the Job Better!

- *Remove solid and abrasive contaminants 1 micron (.000039") and larger*
- *Minimize Engine Wear*
- *Reduce Engine "Down-time"*
- *Extend Engine Life*
- *Lower Operating Costs*

No matter what your Diesel oil filtering problem—either lube or fuel—Fram can help you conquer it. Write for full information today to:

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In Canada: J. C. Adams Co., Ltd., Toronto, Ontario.

FRAM *Filcron*
THE MODERN OIL FILTER

Baldwin-Lima-Hamilton Elects

The Board of Directors of Baldwin-Lima-Hamilton Corporation, following its annual organization meeting announced the election of the following members to the Executive Committee: Edward Hopkinson, Jr., Chairman; Charles E. Brinley, Joseph N. Ewing, Gwilym A. Price, William Wood Prince, George A. Rentschler, John J. Rowe and Marvin W. Smith.

Worthington Appointment

L. M. Evans has been put in charge of the new Rochester branch office of Worthington Pump and Machinery Corporation.

Mr. Evans received his B. S. degree in electrical engineering from the Cooper Union Institute of Technology in New York City. He then took the corporation's engineering training course at Buffalo, and subsequently served as assistant test engineer and general line estimator and representative in St. Louis, Buffalo, and Syracuse.

Alco Vice President

John Thomas has been appointed vice president in charge of product engineering of American Locomotive Company. He has been with the company for 22 years. Since 1948, he had

been manager of the locomotive division with headquarters at Schenectady. Prior to that, he was manager of the Auburn, N. Y. plant.

P & H Appointments

Joseph G. Surmacz has been named to the newly created position of chief industrial engineer of Harnischfeger Corporation, and will be in charge of production control. Before joining the corporation he was chief industrial engineer with the Ingersoll Steel Division of Borg-Warner and with the American Steel & Wire.

Mr. Surmacz has appointed David A. Drewery to assist him as plant industrial engineer. Mr. Drewery will supervise work methods, time study, job evaluation and cost analysis. Formerly he served as plant industrial engineer with Chevrolet motors and the United States Steel Corporation.

Fairbanks Sales Manager

Fairbanks, Morse & Company has recently announced the appointment of Charles A. Mapp as district manager of locomotive sales in the Chicago area. He succeeds C. H. Morse, Jr., who was recently appointed manager of the service department of the Locomotive Division.

Mr. Mapp, a graduate of Duke University, joined the company in the Locomotive Service Department in 1947, and was later promoted to sales representative, Cleveland area, which position he held up to his recent promotion.

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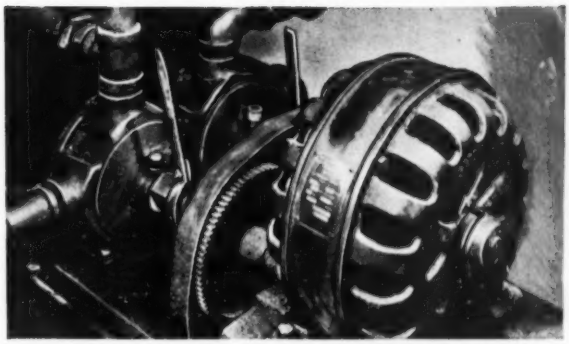

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Skilsaw Executives

At a recent board of directors' meeting of Skilsaw, Inc., manufacturers of portable power tools, Edwin B. McConville was elected as executive vice president, Paul Watts as vice president in charge of sales, and Ralph B. Brundrett as treasurer.

Mr. McConville was formerly trasurer and then vice president of the company; Mr. Watts last held the position of general sales manager; and Mr. Brundrett was formerly comptroller.

Johns-Manville Vice Presidents

William R. Wilkinson has been appointed vice president for sales and Kenneth W. Huffine, vice president for production of the Johns-Manville Corporation.

Mr. Wilkinson, who has been general merchandise manager of the Building Products Division for the past five years, has had 26 years experience with the corporation in sales and merchandising. He succeeds L. M. Cassidy, recently elected chairman of the board and chief executive officer.

Mr. Huffine, has had 26 years of engineering and production experience with the corporation. He succeeds A. R. Fisher, who was recently appointed president.

Hunt-Spiller Chief Engineer

John C. Wallace has been appointed chief engineer for the newly created Diesel Parts Research and Development Division of Hunt-Spiller Manufacturing Corporation.

He is a graduate of Yale University, and prior to joining the corporation, he was a special projects development engineer with Baldwin-Lima-Hamilton Corporation.

Borg Warner President

W. B. Caldwell has been elected as president of Borg-Warner Corporation's Calumet Steel Division, in Chicago Heights, Ill., and Franklin Steel Division, in Franklin, Pa. Prior to Mr. Caldwell's election, Roy C. Ingersoll, president of the corporation, had also held the presidency of the two divisions. Mr. Caldwell previously was vice president and general manager of both divisions.

Chain Belt Appointments

Chain Belt Company of Milwaukee has appointed five new district sales engineers.

Edward D. Williams has been assigned to Philadelphia. His experience has centered on railroads and large industrial companies. Truman J. Hammel will work at the Kansas City office. He was formerly in the Research Engineering Division of the Milwaukee works. R. W. DeMott, Jr. has had considerable experience with industrial plants in the New York area,

and has been assigned to the New York office. Kenneth Burch was formerly associated with the Ohio Edison Company. He will now work out of the Cleveland office. George Robichaud has been assigned to Boston, and was previously with the Baldwin-Duckworth Division at Springfield, Mass.

Perfect Circle Changes

Kenneth Sloane has been named manager of Perfect Circle Corporation's replacement sales region 3, with headquarters in Indianapolis, to fill the vacancy left by the death of Jack Sherry a few months ago. Mr. Sloane was formerly manager of region 8 in New York.

Replacing Mr. Sloane is Jack Taylor who has been with the firm for 18 years. Most recently he has been sales promotion manager at Hagerstown.

Clifford Storey, formerly district manager in replacement sales, has been named sales promotion manager to replace Mr. Taylor.

I-H Retirement

William A. Horthy, research engineer at International Harvester Company's Melrose Park plant recently retired on his 65th birthday after 41 years with the company.

He came to America in 1909 after graduation from the Technical College of Budapest, Hungary. A year later he became a draftsman in the original Harvester tractor works in Chicago. Most of his work was with designs that would burn cheaper grades of fuel more efficiently.

Mr. Horthy plans to do technical writing on diesel engineering theory for textbooks and lecturing.

Heli-Coil Elects

The Heli-Coil Corporation of Long Island City, manufacturer of helical-wire thread inserts, recently announced the election of Eugene M. Lang as vice president in charge of manufacturing. He was former works manager, and has served in various executive and production capacities since 1941. Louis K. Rimer, former vice president in charge of operations of Elgin American Company, succeeds Mr. Lang as works manager and has been elected assistant secretary of the corporation.

Fram Promotes

Howard E. Robinson, general sales manager of Fram Corporation for the past few years, has been elected vice president in charge of sales. He will be responsible for all sales divisions of the corporation.

Milton M. Somers, sales manager of the Automotive Jobber Division, has been promoted to general sales maneger, supervising sales of the Jobber, Export and Industrial Divisions.

Arthur F. Pettet, general manager, has been elected vice president and general manager. Ralph W. Haslehurst has been promoted from auditor to assistant treasurer.

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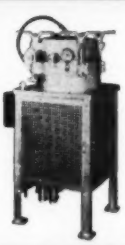

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Heat-Power Research Chairmen

Wilson P. Green, assistant chairman of applied mechanics research at Armour Research Foundation of Illinois Institute of Technology, has been promoted to chairman of a new heat-power research department at the Foundation.

Otmar E. Teichmann, supervisor of fluid mechanics, and Hans L. Wittek, research engineer, will be assistant chairman of the new heat-power research group.

Green, a research professor at Illinois Institute of Technology, will head a department to consist of operating sections specializing in engines, lubricants, fluid mechanics, and thermodynamics. He has been in charge of engines and lubricants research at the Foundation since 1949.

Socony Man Re-Elected

George V. Holton, chairman of the board of Socony Vacuum Oil Company, Inc., has been re-elected president of the Commerce and Industry Association of New York, Inc.

Mr. Holton, who is entering his second one-year term as president of the Association, became associated with Socony-Vacuum as associate general counsel in 1931, when the Vacuum Oil Company, of which he then was a director and general counsel, merged with the Standard Oil Company to become Socony-Vacuum Corporation.

NPA Appointment

Luther D. Shank has been appointed deputy director of the Electrical Equipment Division, National Production Authority, U. S. Department of Commerce. He is on leave as Philadelphia district manager of the Appleton Electric Company.

Mr. Shank joined the NPA in November, 1950, and was formerly chief of the Electrical Products Branch, Building Materials Division. The unit's functions have been assumed by the Electrical Equipment Division. During World War II he was head of the War Production Board's Electrical Materials Branch.

Budd Sales Head

Robert G. Stacy has been made head of railway disc brake sales for The Budd Company, with headquarters in Chicago.

Mr. Stacy has been with the company since 1936 when he began in the blueprint department of the Product Engineering Division. He was one of a group of men who did the research and development work of the disc brake, and subsequently was made assistant sales manager of the Railway Disc Brake Sales Department.

GE Appointments

Alan Howard has been appointed operation manager for the Gas Turbine Division of the General Electric Company's Turbine Divisions. He will be responsible for commercial, engineering, manufacturing and accounting functions of the Division. He was formerly division engineer of the Gas Turbine Division, and in 1946 received the Coffin Award for his contribution to the development of aircraft gas turbines.

J. P. Keller is the new assistant operation manager of the Division. His last position with the firm was that of manager of the Apparatus Department's Industrial Divisions.

Tank
Contents At A Glance

With Liquidometer remote reading fuel storage tank gauges you can check quickly and accurately oil deliveries, consumption and amount on hand. No Diesel plant is complete without one. Liquidometer or Levelometer models are available for tanks of any capacity.

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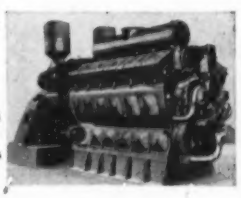

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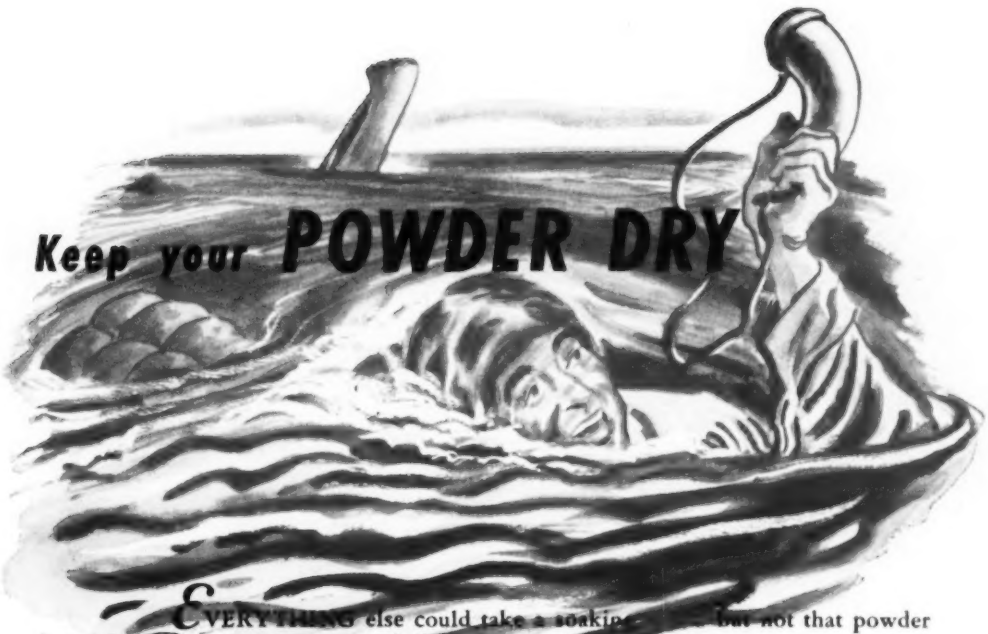

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In Dan'l Boone's day, a man had to keep his powder dry, just as Diesel owners have to keep liners and crankshafts in good working order.

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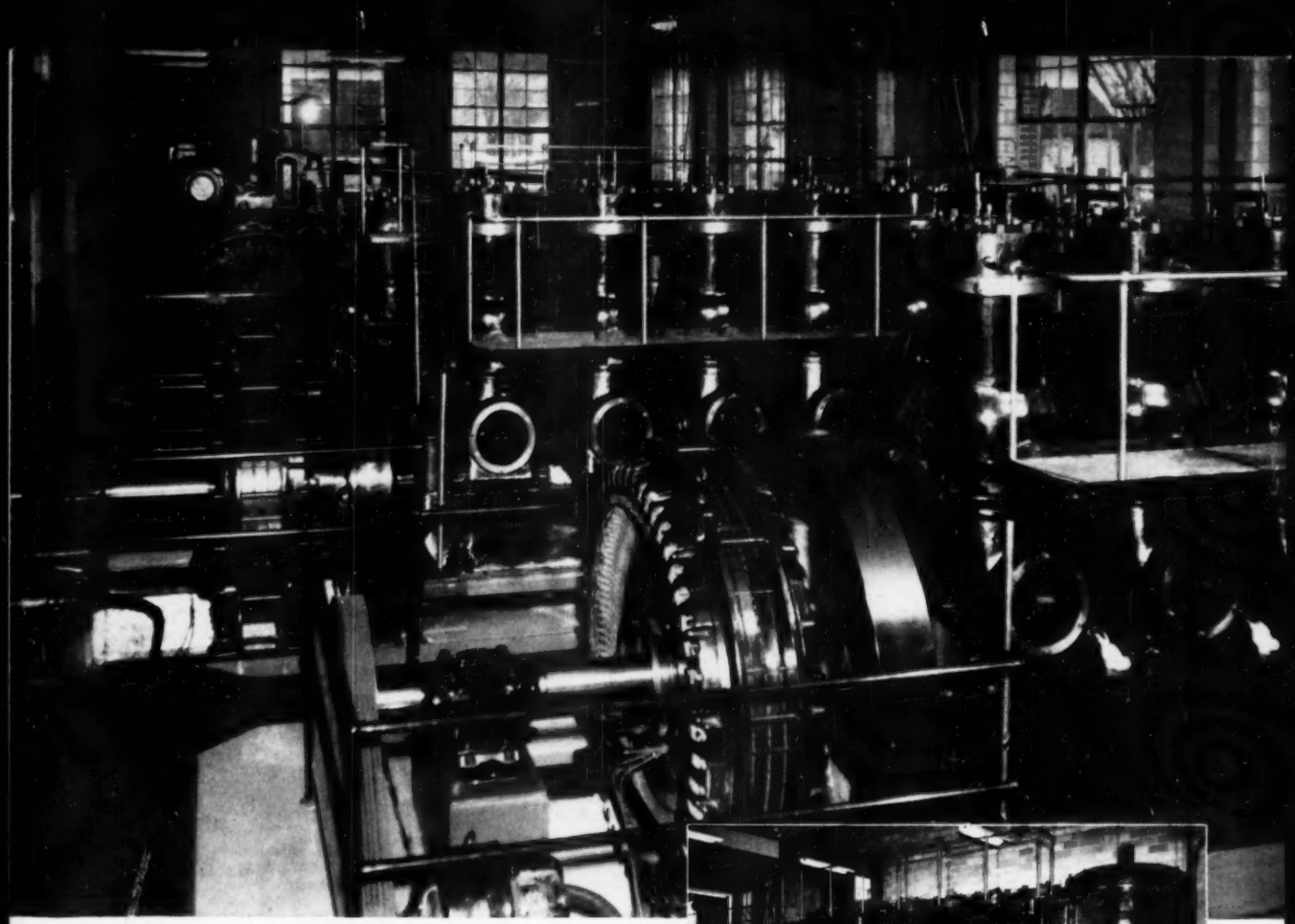

Above: Interior view of Municipal Light Plant, Madelia, Minnesota.

Right: T. C. Splinter, Superintendent (at right), checks performance of big diesel while S. C. Field of Standard Oil's Mankato office looks on.

Ailing diesels get clean bill of health

As power demands grew, so did trouble for the Municipal Light Plant of Madelia, Minnesota. Carbon formed rapidly in the plant's three diesel engines. Ports required cleaning every two to three weeks. Diesels had to be shut down frequently to free stuck rings and remove varnish from cylinder walls.

T. C. Splinter, plant superintendent, put the problem to a Standard Oil lubrication specialist. The lubrication specialist pointed out that the straight mineral oil used in the engines was not able to stand up under the severe conditions of operation. He recommended a switch to STANDARD HD Diesel Oil.

This heavy-duty lubricant made a clean sweep of the troubles. In four years of hard service, STANDARD HD has kept engines clean and rings free. Port carbon has been reduced to a minimum. Engines are now operated up to 8,800 hours before they are inspected or cleaned. Maintenance costs have been trimmed 30% to 40%.

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